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INFLUENCE OF MINISTRY POLICIES ON SCIENCE TEACHING PRACTICES IN COSTA RICA

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ABSTRACT

INFLUENCE OF MINISTRY POLICIES ON SCIENCE TEACHING PRACTICES IN COSTA RICA

By

Alejandro Jose Gallard Martínez

This is a report of a dissertation study conducted in Costa Rica to examine the influence of educational policies and programs designed by the Ministerio de Educación Pública (Ministry of Public Education) on secondary science teachers' attitudes and actions pertaining to science teaching and learning. The method of investigation was interpretive.

Data for this study were drawn from three sources during the months of June-August 1986, December 1986, January 1987 and May 1987. Data included:

1. Interviews were conducted in Spanish, and translated into English, with Ministry officials, university teacher educators and administrators, representatives of educational associations, union administrators, Ministry-appointed science teacher support personnel, and 18 secondary science teachers.

2. Science teachers' lesson plans, examinations and local school site policy bulletins; and

3. Publications, including newspapers, and official Ministerio de Education Pública (Ministry of Public Education) and university documents.

Findings

Analysis of interviews, official documents and science teachers' lesson plans indicate that educational policies and programs are

designed to coordinate education with Costa Rica's plan for national development of science and technology. A vehicle used to meet this objective is the Contenidos Básicos de Ciencia, Costa Rica's national science program for grades K-12. The objectives of this program were established by the "leadership elite" of Costa Rica. For the purposes of this study, the leadership elite is defined as individuals from both the private and governmental sectors. The private sector is represented by those individuals who set manufacturing and industrial objectives at the national and multinational levels. The leadership elite of the governmental sector is considered to be elected or appointed officials who direct national and international policy for Costa Rica. In this dissertation, that person is the Ministro de Educación Pública.

During interviews, science teachers' typically stated that science learning should be practical and useful for students to meet their everyday needs. However, the teachers' attitudes and beliefs about science learning were influenced by numerous factors, including (a) educational policy that obligates secondary science teachers to teach to secondary students of Costa Rica scientific knowledge represented in the Contenidos Básicos de Ciencia, (b) national examinations based on the Contenidos Básicos de Ciencia, (c) administrative policies of local schools, (d) a rigid system of student assessment, (e) a lack of inservice opportunities and resources at their schools and (f) the socio-economic status of their students.

The lesson plans of the teachers in this study indicated that their attitudes and beliefs, previously described, about science learning were superseded by these influences. This resulted in a style of teaching that emphasized teaching factual knowledge about scientific concepts and principles as opposed to practical applications of

scientific knowledge. The science teachers found themselves in a situation of conflict between students' needs, policy requirements and the limitations of their own backgrounds.

DEDICATION

to

Lupita E. Martínez Echeverria

Alfredo Martínez Echeverria

David G. Oliver, Sr.

Lucila R. Góngora de Gallard

Alex, Paul, and Javier Gallard

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>
> Dr. Scott Whiteford never hesitated to share with me his broad research experience in Latin America. He also provided for me a very unique experience working with him at Michigan State University's Caribbean and Latin American Studies Center.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

This is a report of a case study conducted in Costa Rica to determine the ways in which educational policies and programs influence teaching practice in secondary science classrooms of that nation. In order to shed light on this issue, it was assumed it would be important to understand secondary science teachers' role perceptions, and their attitudes about policy and curriculum. Thus, an interpretive method was used to acquire and analyze data.

Chapters I through III provide the reader with appropriate background based on a literature review and a historical overview of education in Costa Rica. Methodology is described in Chapter IV. Interviews, lesson plans, examinations, and other official documents were used as a basis for analysis. Interview data and other documentation are presented in detail in Chapter V of this study. Analysis of data also is provided in Chapter V. Conclusions and recommendations are found in Chapter VI.

Background for the Study

A Framing Vignette

One of the sites of this study was Limón, a rural port on the Atlantic side of Costa Rica. The day I arrived at the local high school, for the first set of interviews, the area had been under a thick haze for a few days. The section covered by the haze had, the day before, extended to San José, the capital city of Costa Rica.

As I walked onto the school grounds looking for the administration's office, the principal came bounding down the passageway and greeted me with: "Mientras la bruma afectaba a Limón no habia problema, pero ahora que llego a San José si mandan científicos a investigar que era lo que pasaba en Limón." (While the haze affected only Limón, there was no problem. But now that it has arrived in San José, they send scientists to find out what is happening here.)

After this initial greeting, the principal invited me into his office and proceeded to tell me of how grateful he and his staff were that someone had come to study their school. His attitude was based on a belief that this area--the school and students--were ignored by the Ministerio de Educación Pública (Ministry of Public Education), and other public offices. Apparently my visit was anticipated by other than the principal because students and teachers would voluntarily walk up to me and ask if I was the "gringo" who was interested in their school.

As I met people and walked around, I was struck by the different skin colors of the staff and students. Blacks, mulattos, and mestizos (descendants of whites who married with the indigenous population) comprised the racial mixture of the school. The makeup of the people stood out. Up to this time, my research efforts had been concentrated in San José where a majority of the students were white, with a few mestizos.

One of the people I met was the school's cook. She informed me that her salary and the money to purchase food were provided by the school's staff and by students who could afford to pay something. Money for school lunches had been eliminated by the Ministerio de Educación Pública in order to pay for a special housing project

initiated by the newly elected president of the country. This was to be one of my first insights into how a rural area could be affected by decisions made at the national level.

During the course of my visits to Limón, I kept asking myself the question: "What can these students in this region do with a high school education, and the science they are learning?" This question kept coming up because this is a socially and economically depressed area with very little local industry. Also, the education these students were getting was designed to prepare them for university studies, and did not seem to take into consideration their local needs. This led to many other questions that perhaps can be subsumed under one large question: "How do science teachers at this school respond in their teaching to the discrepancy I perceived between curriculum and local needs? However, in-country data collection was not the only experience that helped shape some of my thinking in this research effort.

Other Experiences That Helped Frame the Study

During December of 1984, the first Inter-American seminar on science education took place in Panama City, Panama. The theme for this scholarly exchange of papers was "Science Education and Cultural Environments of the Americas" (Gallagher & Dawson, 1984). Participation in this seminar afforded this researcher the opportunity to converse with more than 40 science educators from the Caribbean and North, Central and South America.

Conversations with these science educators focused on the teaching of science in their countries. As their stories unfolded, a pattern of common problems emerged. These problems were a dearth of textbooks, an

emphasis on rote memorization of science facts, insufficient school and classroom resources, inadequately prepared science teachers, student and teacher pressure resulting from meeting the demands of a national evaluation system and the influence of a centralized educational bureaucracy which was remote from teachers and schools.

Information gathered from these conversations, as well as others, served as the basis for several questions: Why were the problems related by these science educators, in many instances, similar to those found in the U.S.A.? How is the educational system of one country similar or dissimilar to any other? What objectives do different countries have for science education? What similarities or dissimilarities exist between countries in the way science is taught? How is science classroom practice influenced, if indeed it is? Does the teaching of science in a less developed country take on a different role and function than that of a developed country? What does the notion of development mean as it pertains to science education? These questions served as a catalyst for the development of this author's research efforts and resulting report.

The above questions cover a wide range of general topics about development, education, policy and the intricacies involved in science teaching. As such, they also helped this researcher to reflect within the framework of a much broader context. For example, what is the role of developed countries in respect to the development efforts of less developed countries? In terms of developing a country, who defines the function and role of education pertaining to development efforts? Is it defined by educational planners, national governmental officials, private sector leaders from multinational corporations, or a combination of these or others? Is it based on perceptions of need for

economic and technological advancement? If so, whose perceptions are most influential? Within the context of the previously asked question, how are the development of educational policy, the curriculum and science teaching practices influenced?

There are many issues to be considered. However, for the purposes of this study, they fall into three main categories: (1) the role of education in development; (2) how this role affects the formation of educational policy; and (3) the effect of educational policy on science teaching. These three areas served as the framework for the acquisition and interpretation of data and the writing of this dissertation. Because the interpretive method was used in this study, these three issues were more clearly defined during data collection and analysis. Thus, another experience which served to generate framing questions was the direct result of in-country efforts.

Framework for the Study

Recognizing and identifying factors that have a direct bearing on the development and maintenance of a system are important tasks when one is studying and trying to understand that system (Gallagher, 1987). This suggests that determining causes and their effects on those who work within a system (e.g., the educational system of Costa Rica) is important because there is a relationship between the structure of a system and those who work within it (DeWalt and Pelto, 1985). Casley and Lury (1984) suggest that surfacing views of those within the system assists researchers in determining and understanding departures from policy by these players. Conversely, the surfacing of these same views would also seem to help policymakers understand why some always comply with designated procedures.

DeWalt and Pelto (1985) also explain the importance of capturing linkages between those who work in a setting and the system itself. They state that "A researcher concerned with political events in a particular region or community would identify all the pathways or channels through which potential messages and influences pan between the local/regional scene and the larger political system" (DeWalt & Pelto, 1985, p. 190). They suggest that one needs to be concerned not only with what pieces define a system's context, but also how they fit together to ensure its operation.

This implies a complex cause-effect relationship between the attitudes and actions of science teachers regarding established policy and programs (Wood, 1988 & German, 1988). Thus, cause-effect relationships are not limited to only those responsible for actualization (science teachers). Administrators and other policymakers who implement and disseminate policy and programs are also influenced when one is studying cause-effect relationships. In other words, those who suggest, decide, or actualize educational programs and policy are affected by multiple influences (German, 1988; Craig & Tester, 1982).

Some of these influences are immediate and conspicuous, while others are remote and the connection is not as apparent. Another way of looking at this is that some cause-effect relationships are localized and found within the classroom while others are not. The point, though, is that these factors, in some way or another, are linked to each other. "Naturally, units of analysis are comprised of smaller units and are themselves part of larger units. In the same way, processes are components of larger systems, and certain small subprocesses" (DeWalt & Pelto, 1985, p. 2).

The idea to this point is to consider the notion that there exist influences at the national level of a country (e.g., national administrative policies) that can sway science teachers' attitudes and beliefs. At the same time, there are other influences at the local school level (e.g., principal's administrative mandates) that also serve to impel science teachers to teach in a manner which is consistent with national education policy.

The organization of Costa Rica's educational system (policy, programs and teachers, for example) is designed in a manner as described by DeWalt and Pelto. Specifically, there are three distinct levels that form the educational system: Nivel Central (Central Level), Nivel Regional (Regional Level) and the Nivel Local (Local Level). The Ministerio de Educación Pública, or the Nivel Central, forms policies and programs; the Nivel Regional enforces these same policies and programs; and, all of the private and public schools, Nivel Local, actualize the programs and adhere to policies.

On the one hand, an analysis may confine itself to each separate level, based on its separate functions. On the other hand, it is how each carries out its unique functions that inevitably locks each of the three levels into forming a much larger picture that can be considered as the educational system itself. Furthermore, if the educational system of Costa Rica can be considered to have internal influences based on their individual responsibilities, then so can this same organization be considered to be a component of other national-level entities such as the industrial and agricultural sectors. Each of these sectors has its own unique function and, at the same time, can be influenced by each other's unique needs.

For the purposes of this study, the underlying premise is that Costa Rican science teachers' actions are linked to forces that stem from within the educational system (policies and programs), and to forces outside of the educational system. An example would be the relationship between: (1) the Ministerio de Educación Pública; (2) the development of the Contenidos Básicos de Ciencia (the K-12 national science program for Costa Rica, described in Chapter II); and (3) science teachers' perceptions of their roles. DeWalt and Pelto (1985) refer to these interlocking variables as micro and macro level linkages.

Micro and Macro Linkages

Bennett (1985) defines "...the 'micro' and 'macro' as referring to interactive processes of change, involving diffusion, influence, and defensive adaptations" (p. 23). The terms "micro" and "macro", as used here, do not imply differentiating sizes or proximity. Their use is to suggest that the actions of individuals or attitudes of institutions are related to multilayers of influencing forces. In other words, the whole of the interrelated forces can be considered the milieu which influences individual actions and attitudes (German, 1988).

> ...'micro/macro'. This can clearly refer to at least two different things. First, the size or magnitude of the social forms and processes: 'micro' in this sense means 'small-scale', and 'macro', 'large'. Secondly, the phrase may refer to 'local' social forms as contrasted to 'external' forms which may intervene or influence the 'local'. Logically, this duality creates a four-fold table: One may have 'small' forms with highly 'local' peculiarities, but also 'local' forms which are duplicates of the 'large' and 'external' forms; and so on (Bennett, 1985, p. 24).

For the purposes of this study, the idea of micro and macro linkages helps a researcher understand that when secondary science teachers adapt their practice to their classrooms, it involves handling

the social and cultural milieu in which they work (DeWalt & Pelto, 1985). This is because the notion of micro and macro linkages serves to underscore the idea that practice may be linked to influences that seem to be immediate (micro), but perhaps have evolved over time or emanate form a source not directly connected to science teaching (macro). For example, science teaching may be affected by local school policy (micro), and also by national education policy and programs (macro). However, regardless of the source of influence, a central aspect of this study is to understand how secondary science teachers react to this milieu when teaching science.

Purpose of the Study

The purpose of this study is to determine the influences on secondary science teachers as they plan for and carry out teaching. This includes the external forces that influence teachers' decisions and actions and their attitudes and beliefs about science teaching which have been formed through a variety of experiences.

Science teachers of Costa Rica, as in most nations, work within a context that includes economic, political, sociological and technological pressures. Another aspect of this scenario are the views of governmental and private sector leaders, who comprise the nation's elite, and who assume responsibility for developing national educational policies and programs. The sum of these forces, which range from local to international, is the milieu in which Costa Rican teachers of science must carry out their work. These forces shape the development of educational policy and programs, and also influence teachers' decisions in planning lessons, instructing, evaluating, or when engaging in other classroom activities.

Besides educational policies and programs, there are many other variables to consider when one thinks about how teaching and learning is accomplished in a science classroom. For example, science teachers are confronted with pressures resulting from the social and economic conditions in which students live. Other factors to consider might include teaching in an urban or rural setting, a private or a public school, the purposes of education as defined by parents, or by national or international developmental interests, unequal distribution of resources, community expectations for education, and other private sector demands.

The Role of the Teacher

Schooling also should be thought of as a way to prepare youth for the future. Since a great deal of what the student is to learn is theoretical in nature and foreign to his/her environment, educational agents, such as teachers, and curriculum are established to promote and maintain the educational system's views (Thompson, 1985; Altbach & Kelley, 1979). It does not seem likely that teachers automatically become educational agents. What perhaps does take place is that science teachers mold their activities around policies and programs which are purposefully designed to attain certain key objectives. Thus, how teachers teach may not necessarily reflect their views about teaching and learning, but may result from a "blending" of teachers' views and the views of those who establish policy and programs, such as teachers' formal training, their own social and economic backgrounds and their attitudes and beliefs developed as a result of these factors.

The idea that teachers can serve as educational agents may be an important point to realize. Specifically, Barnes (1979) hypothesized a

link between teaching and learning. In this study, an attempt was made to determine secondary teachers' attitudes regarding a curriculum. Barnes found that some teachers viewed their role as being that of the literal purveyor (transmitter) of the designated curriculum, regardless of students' differing abilities and social economic status, and other teachers viewed the curriculum as something to be molded around student's experiences and realities (interpreters).

The question arises as to whether teachers are transmitters or interpreters because their behavior is linked to some influence as opposed to deliberate behavior on their part. As an example, science teachers of Costa Rica must comply with administrative mandates. In other words, they conform to an unwritten code of expectancies (cultural norms) thereby acquiescing to the forces that have shaped educational policies and programs. As a result, science teaching efforts are directed towards the development of a body of science knowledge which embodies a set of principles and ideals which are a consequence of forces that have influenced the development of educational policy and programs. Thus, how teachers deliver science to students may be linked to administrative norms, as well as other influences.

Several issues have been presented in the previous pages that affect science teaching in Costa Rican high schools. These include: (1) economic, political, sociological and technological forces that influence the science education; (2) policies and programs that are designed to guide science teaching in Costa Rica; (3) students' needs for scientific knowledge, both now and as adult members of the society;

and (4) how these and other forces influence science teaching. The relation among these four entities is the arena of analysis for this study.

Since the Ministerio de Educación Pública develops policy, can it be considered the broker for the forces that have influenced the development of education policies and programs designed to attain certain key objectives that have been determined by economic, sociological, technological and political forces and the leadership elite of Costa Rica? If so, would these policies and programs be considered a conduit through which the various agendas are fulfilled, thus setting the role of science teachers to one of satisfying the aforementioned sources of influence?

In essence, science teachers may be delivering a body of science to students based on economic, political, sociological and technological influences embedded within the curriculum. If so, are science teachers cognizant of the role they are playing within this setting? Do teachers realize that in meeting the objectives of the Contenidos Básicos de Ciencia, they are also fulfilling the demands of those who guide the educational system? To what degree are teachers aware that their role is subjected to many influences that lie beyond their control?

Research Questions

Two major questions serve to focus the research questions developed in this study. First, how are education policies in Costa Rica formulated? Second, how do these policies influence practice? These two framing questions raise four subsidiary questions about the relation between educational policy and programs and science teaching.

1. What economic, political, sociological and technological forces influence secondary science teaching in Costa Rica?
2. How do these forces influence official policy and programs of the Ministerio de Educación Pública?
3. In what ways do practicing science teachers adapt to, and adapt, the objectives of the Contenidos Básicos de Ciencia?
    a. What purposes of science instruction are demonstrated and expressed by science teachers?
    b. Are there differences between science teachers in an urban and rural setting and in private and public schools? If so, what are they?
4. Does a vehicle exist through which science teachers can participate in national educational policy decisions?

This study may help shed light on how governmental policies and programs influence science teaching. This includes science curriculum development and training of science teachers. Therefore, research efforts have been directed towards understanding the environment in which science teachers of Costa Rica work. This includes an attempt to determine how their attitudes and beliefs regarding science teaching and learning are influenced by this environment. Emphasis was placed on understanding the ways in which the Ministerio de Educación Pública and its formal plan for science teaching (Contenidos Básicos de Ciencia) influence the actual classroom practice of those who teach secondary school science.

Summary

For this study, there are three contextual variables upon which this researcher concentrated. The first is the Ministerio de Educación

Pública, the organization which develops and oversees the implementation of educational policy for Costa Rica. Second is the Contenidos Básicos de Ciencia, the actual K-12 national science program developed and disseminated by the Ministerio de Educación Pública. Third is science teachers and how they adapt their classroom practice to both of these.

CHAPTER II

HISTORY AND STRUCTURE OF COSTA RICA'S EDUCATIONAL SYSTEM

Introduction

Why Costa Rica? The answer to this question is both political and academic. Politically speaking it was, and still is, one of the most stable countries in the region. Academically, Costa Rica has a history of commitment in improving educational opportunities for its citizens.

Several other factors make Costa Rica stand apart from other Central and South American countries. For example, there are more teachers than soldiers (Waggoner & Waggoner, 1971) and one-third of the national budget is designated for education (Greenwald, 1986). Costa Rica also has, since 1949, a representative republican government consistent with its constitution (Aguirre International, 1988) and a 120-year history of free and compulsory primary education (Waggoner & Waggoner, 1971).

Two other important features distinguish Costa Rican history from that of other Central and South American nations. First, due to a scarcity of precious metals, only a few colonizers immigrated to Costa Rica and settled in existing principal population centers. Second, such a small number of colonizers, scarcity of precious metals and isolation from the other colonizers are the causes for the distinct manner in which Costa Rican society developed, when compared to other Central American nations (Aguirre International, 1988).

Economic System

Costa Rica presently has an economy which is partly controlled by the government and partly by the private sector. The underlying rationale for this mixed economy rests on the notion that unrestrained capitalism causes socioeconomic dislocations and inequalities. The solution is for the government to constrain the free market through its constructive involvement in the economy in order to redistribute income and to improve the living standard of the poor. Costa Rican policy has been to keep military expenditures quite low, and expenditures for education and health high thus improving the quality of life for its citizens (Aguirre International, 1988).

Observers of the economic scene point out, however, that excessive government control has produced a large bureaucratic structure which is, in part, inefficient and ineffective. Consequently, some believe that there should be a shift towards enhancing the participation of productive individuals and private firms. On the other hand, observers insist that there is a growing socioeconomic inequality and a misdirection of social services away from the needy poor to the middle class. Although many believe that a public sector administrative reform is long overdue, it does not seem likely that the government will cut back the number of public servants (Aguirre International, 1988).

Costa Rica's economic strength rests with it four major exports--coffee and bananas, sugar and cattle. Its economic development is particularly vulnerable to market fluctuations in those commodities, as it is to the price of oil, a primary import. Market fluctuations of these four major exports, along with worldwide inflation and a corresponding devaluation of the colon, have caused an enormous

imbalance of payments with its foreign debt. Costa Rica has historically been reluctant to institute tax reforms to address this imbalance due to pressures from the private sector (Aguirre International, 1988).

Educational System of Costa Rica

History of Education in Costa Rica

There have been many volumes written about the history of education in Costa Rica. Aguilar Bulgarelli, Araya Pochet, Cardoso Flamarion, González Viquez, Meléndez Chaverri, Monge Alfaro, Obregón Loría, Pérez Brignoli, and Soley Guell, are examples of some of these authors. However, González-González (1984) seemed to have the most comprehensive and up-to-date review of the history of education in Costa Rica. Therefore, the following description is based on González-González's (1984) book entitled "Educación Costarricense."

Education During the Colonial Period

During the colonial period--from the 16th century to the first two decades of the 19th century--education in Costa Rica was dominated by educational policy developed in Spain. Only the children of the noble attended school because their families provided financial support to the church. Interestingly enough, laws established for colonies by Spain mandated that all free people were to be educated.

At this time, textbooks which were considered to be anti-Catholic were prohibited by the Spanish Inquisition. A specific target of this prohibition were books of science. In Costa Rica which was known as the province of Costa Rica, only two books were permitted to be used for education. One was called "El Catón." This textbook was used to

develop religious and moral fiber. The other was entitled "La Cartilla," which served to teach students how to read and write.

Churches located throughout the country were used as the first schools, and priests as teachers. The use of churches and priests for education was necessary because Costa Rica did not have money enough to pay teachers 25 pesos per year.

In the early part of the 19th century, the educational system, as described earlier, remained unchanged. However, in 1810 the "Leyes de Cádiz" (Laws of Cádiz) were passed by Spain in collaboration with the representatives of the colonies. As a consequence, books with a greater diversity of theories were permitted to be used in Costa Rica. These books were written by the liberating philosophers of that period, such as Montesquieu, Rousseau, Voltaire.

It was during this time period that teachers from other countries came to Costa Rica. They promoted the ideas that: (a) school sites should be established and (b) the objective of education should be to provide the opportunity to study ideas that had been prohibited earlier.

The influence of resident foreign teachers also helped create "La Casa de Enseñanza de Santo Tomás" (Saint Thomas Educational Center). This educational center provided classes in Spanish grammar, philosophy and the sacred canons of the Catholic Church. The makeup of the student population remained the same. Students still came from the same families educated in the previous years.

Education During the Post-Colonial Period

In 1821 Costa Rica was declared independent from Spain, but educational objectives and academic themes remained unchanged until

1843. In 1843, leaders of Costa Rica became alarmed by the high rate of illiteracy in their country. This concern was the rationale used to convert the "Casa de Enseñanza de Santo Tomás" into a university. Primary education, though, was virtually ignored because all educational priorities were directed towards the newly established university.

When Mauro Fernandez (considered the most influential figure in the history of Costa Rican education) was appointed Minister of Education in 1887, the university was abolished and high schools for males and females were established. The leaders of Costa Rica were still concerned with the high rate of illiteracy. In order to combat this problem, legislation was initiated which declared that the public's opportunity to obtain an education is a right. Furthermore, the government of Costa Rica should guarantee this right.

Participation in schools was still very limited and the problem of a high rate of illiteracy remained the same. As a consequence, an amendment to the Constitution of Costa Rica was established. This constitutional amendment made primary education, for all people, obligatory and free. The cost of primary education was to be borne by the government.

It was during the last years of the 19th century, and the first 40 years of the 20th century, that two changes in the educational system book place. Educational legislation passed during this time was influenced by the leaders of Costa Rica and resident educators from other countries. The first change was to readdress the philosophical foundations for education which were influenced by the philosophy of positivism and national leaders of Costa Rica.

The combined forces of governmental leaders and invited scholars gave birth to two ideas. The first is that teachers should have absolute authority in the classroom. The other belief was that education should stress academics. At the same time, these thinkers introduced some of the more radical ideas of this period (Marxism) into the curriculum of Costa Rica. However, these ideas were rejected by the conservative and traditional segments of society.

Within this period, a radical change took place in Costa Rica with the founding of the Universidad de Costa Rica in 1942. Radical because establishing this university meant that students who were finishing high school did not have to go abroad to study. Thus, a university education was available to more citizens of Costa Rica.

Education During and After the Revolutionary Period of 1948

Around 1945, a group of young Costa Rican professionals were dissatisfied with education in their country. They started a reform movement in education primarily based on the educational thinking of this period. This same group of people also worked towards eliminating political influences on the educational system. As a result of their efforts, an organization known as "El Centro para los Estudios de los Problemas Nacionales" (The Center for the Study of National Problems) was founded. Years later, this organization became known as the Partido Liberación Nacional" (The National Liberation Party).

After the revolution of 1948, the "Partido Liberación Nacional" took control of the government. When they came into power, a twofold agenda was established for education. One objective was to initiate an analysis of the present educational system, and the other was to find ways of improving the same. As a consequence of this new government's

push, a new constitution was established in 1949. The importance of education was underscored by the inclusion of a complete chapter on education.

Article 77 of the new constitutional chapter on education stated that all public education was to be organized in such a fashion that preschool through university studies were to be coordinated and that the first two levels (primary and secondary) were to be a preparation for the next tier. In other words, preschool was to prepare students for primary school, which was to ready them for high school, which was to equip them for university studies. Thus, a person's education was to be cumulative, and learning was to be for the sake of going on to the next highest level.

Another fall-out of this reform movement was Article 81, which established the "Consejo Superior de Educación" (Superior Council of Education). The intent in forming this council was to weaken the political influence of a newly-appointed Minister of Education every four years. This committee was charged with overseeing the continuation of national educational plans from one administration to the next.

Also during this period, science and technology were included as components of the national curriculum. Adding science and technology to the national curriculum was based on modernism theories of development that stressed the need to prepare a country's citizenry for work in the industrial sector.

1950's and Today

In 1957, Costa Rica established "La Ley Fundamental de Educación" (The Fundamental Law of Education). This law was framed in democratic

ideology and the basic objective was to ensure that education would take place in an atmosphere that stressed the development of human resources. In the years following the establishment of this law, another reform took place. This is the last reform to date.

The latest reform focused on two aspects of education--the junior high years and qualitative aspects of the educational infrastructure. The philosophical rationale for this reform was the same as the last, which is to prepare citizens for work and to contribute to preserving democracy in Costa Rica. Secondary education was divided into three years of general and two years of specialized study. The second change was to improve the quality of teacher preparation and inservice teachers.

There seems to be sufficient evidence in the history of Costa Rican education that one can assert the presence of political influence and notions of functionalism. However, it seems as if it was not until the 1940's and beyond that these two influences became readily apparent.

Administrative Structure of Costa Rica's Educational System

Unlike the United States, the country of Costa Rica has a centralized system of education. As discussed in Chapter I, decisions regarding private or public education are made at the national level and disseminated throughout the nation. The Ministerio de Educación Pública is the organ through which educational policy is prepared and disseminated. The Ministerio de Educación Pública is directed by the Ministro de Educación Pública (Minister). A new minister is appointed by the President of the Republic every four years.

Public schooling in Costa Rica is free through Educación Diversificada (High School). School attendance is compulsory from kindergarten through the eighth grade or when a student reaches 15 years of age.

With the exception of Gámez, who served for eight years, from 1970 to 1978, a new Ministro de Educación Pública is appointed every four years by the incoming president of the Republic of Costa Rica. As a consequence, every four years not only is a Ministro de Educación Pública appointed, but there is also a new educational agenda to be fulfilled.

The educational system is composed of three organizational levels: Nivel Central (Central Level), Nivel Regional (Regional Level), and the Nivel Institucional (Institutional Level). Each level has its own internal administrative structure and function. However, all national educational policies come from the Nivel Central, which supersedes any administrative decision made at the lower two levels. An explanation of each organizational level is described below.

Nivel Central (Central Level)

The Ministerio de Educación Pública is located in the Nivel Central. This is the central educational administrative level for the nation. It consists of various sections or departments. Specifically, there are five departments found within the Nivel Central or the Ministerio de Educación Pública. They are the (1) Organo de Decision (Decision-Making Branch); (2) Organo de Planeamiento (Branch of Educational Planning); (3) Organo de Asesoria Tecnica (Branch of

Technical Assistance); (4) Organo de Ejecución y Supervision (Branch of Management and Supervision); and the (5) Organo de Apoyo (Branch of Support).

The function of the Organo de Decision is to decide what is/is not educational policy in Costa Rica. Recommendations to the Organo de Decision for all new educational programs is handled by the Organo de Planeamiento. The Organo de Asesoria Tecnica is charged with the placement of all educational personnel in the nation's public schools. Ensuring that the Ministerio de Educación Pública's programs and objectives are being completed throughout the nation is the role of the Organo de Ejecución y Supervision. Organo de Apoyo is the branch that provides logistical support for Costa Rica's educators.

The major department is the Organos de Decision which consists of a Consejo Superior (Superior Council) and the Minister's Cabinet (Cabineta). Both the Consejo Superior and the Cabineta are presided over by the Ministro de Educación Pública. This level is the most influential because all recommendations regarding Costa Rica's educational system are finalized by the Ministro de Educación Pública in coordination with the Consejo Superior (Superior Council). Decisions made by the Ministro de Educación Pública and the Consejo Superior can be considered mandates which apply throughout the educational system (public and private) of Costa Rica.

Nivel Regional (Regional Level)

The second organizational level is the Nivel Regional, composed of a regional director and his or her staff. The function of this organizational level is to represent the Ministerio de Educación Pública (Nivel Central) on a regional level and to ensure execution by

the Nivel Institucional (next or lowest level of official policy and programs. Costa Rica is divided into 20 separate geographical areas, or regions, as follows:

1. San José
2. Heredia
3. Puriscal
4. Cartago
5. Turrialba
6. Alajuela
7. San Ramón
8. Puntarenas
9. San Carlos
10. Zona Norte
11. Nicoya
12. Cañas
13. Santa Cruz
14. Liberia
15. Coto Brus
16. Perez Zeledón
17. Buenos Aires
18. Limón
19. Guápiles
20. Quepos

Nivel Institucional (Institutional Level)

The third organizational level is the Nivel Institucional. This level consists of all private and public schools throughout the nation. All principals, classroom teachers and any other personnel working in schools make up this level. This organizational level is held responsible to the Nivel Regional, which in turn is responsible to the Nivel Regional, which in turn is responsible to the Ministerio de Educación Pública (Nivel Central).

Of the three levels of Costa Rica's educational system, the Nivel Central is the most influential. As stated previously, this level is known as the Ministerio de Educación Pública and defines official policy and programs for the other two levels. This includes curriculum, evaluation, teacher placement and salaries (for public schools). Notwithstanding this fact, there are certain areas in the administration of private schools that the Ministerio de Educación Pública does not involve itself with. These are selection of staff, salaries and administrative policies that do not supersede or interfere with national education policy.

There are two other areas of interest to contemplate when analyzing the design of the educational system of Costa Rica. These are the design of the system itself and the authority to develop policy.

The system itself is designed like a pyramid, with the broadest portion (base) defined as the Nivel Institucional (all the private and public schools of Costa Rica). On the other hand, when one looks at where the authority to determine policy exists, the Nivel Institucional and the Nivel Central change positions. In other words, the narrowest part of the pyramid (apex), in issues relating to policy-making, belong to the Nivel Institucional; the Nivel Central becomes the broadest section of the pyramid (base) through which all official administrative matters are funneled. The pyramid is inverted in issues pertaining to curriculum and evaluation, placing the greatest amount of autonomy in the hands of those who work in the Nivel Central.

Private and Public Education

There are six levels of education in Costa Rica: Pre Escolar (Preschool), Educación Básica (Basic General Education: elementary and junior high school), Educación Diversificado (senior high school) and Educación Superior (university), Educación de Adultos (Adult Education), and Educación Especial (special education).

1. Pre Escolar (Preschool) for a minimum of one year's duration. This is not obligatory.

2. Educación Básica is of nine years' length, obligatory starting from age six, and divided into three cycles of three years each.

3. Educación Diversificado lasts from two to three years depending on which of the following routes a student takes:

   A. Academics - Sciences and Letters are studied together for two years.

B. Technical Education - This lasts three years and students may opt for one of the following: Industrial, Agriculture and Livestock, Commerce, or Arts.

4. Educación Superior the length of which depends on a student's program at either a university or a technological institute.

5. Educación de Adultos can be either formal or nonformal and continues until the student has met his/her objective. This branch of schooling is for people who have left school, as youth, and are attempting to complete their primary or secondary education.

6. Educación Especial for students who, for physical or psychological reasons, cannot participate in other educational programs.

Objectives of Pre Escolar

The objectives of Pre Escolar are to prepare the child physically, and mentally to enter the first year of Educación Básica (Kindergarten).

Objectives of Educación Básica

The goals of Educación Básica are to graduate citizens who can contribute to society in a positive manner, develop a good attitude towards self and work and obtain the academic skills necessary for Educación Diversificado (10-11 or 12).

Objectives of Educación Diversificado

Educación Diversificado has three goals. The first is to instill in students a greater sense of civic responsibility. The second is to develop citizenry who will be contributing members to the work force. The last goal is to prepare students for advanced studies at a University, or a Technical-Vocational School.

There are two common threads throughout the objectives of each level of education. The first is that each block of grades, as well as each grade, is preparation for the next level or grade. Secondly,

education is to preserve democracy by developing better citizens as well as increasing the economic potential or possible production capacity of Costa Rican students.

Courses of Study for All Students of Costa Rica

The Ministerio de Educación Pública decides the educational objectives, subjects and the content within each subject that is taught in Costa Rica for the first 11 to 12 years of formal education. The design of the educational framework is uniform. As such, regional and/or social-economic differences among students are not accounted for. All students, regardless of who they are or where they live, study the same subject matter and content objectives.

The following subjects are studied by all primary through secondary students in both private and public schools. Though some schools (mainly private) may offer more subjects, they must, at a minimum, offer the following:

Cycles I and II (First Six Years of Primary School)

Mathematics
Natural Sciences
History and Geography
Spanish
Industrial and Agricultural Education
Music
Religion
Physical Education
Home Economics
Art (starts in third year and goes to sixth)

Cycle III (Last Three Years of Primary School)

Spanish
Social Science
English or French
Mathematics
Sciences
Industrial Arts or Home Economics
Art

Musical Education
Physical Education
Religion
Civics

Nivel Diversificada (High School)

Spanish I & II
Social Studies I & II
Mathematics I & II
Science (Biology, Chemistry, Physics)
Foreign Language
Psychology (10th)
Philosophy (11th)

It seems that in designing this program of studies the assumption was made that all students need to study the same subject matter. If this is the case, then one would only need to point to differences between the urban and the rural sectors to understand the fallacy of this logic. Even though offering all students the same curriculum is considered a step in the democratization of educational opportunity by the Ministerio de Educación Pública, it should be remembered that not all students come from the socioeconomic background, nor have the same future opportunities.

For example, in Costa Rica, most students only finish the sixth grade (Greenwald, 1986). Those who leave school are mostly from the rural sector, or from the urban area where they represent the lower end of the socioeconomic spectrum (La Nación, 1987). However, those students who do go on to high school, graduate and enroll in a university, will finish the tertiary level.

According to Greenwald (1986), 95% of the students who enter a Costa Rican university will graduate with a terminal degree. The problem, though, is that the student population at the university represents only 2.2% of the total populace.

These statistics point to the possibility of the existence of several societal issues, such as health, welfare and an unequal distribution of resources which may contribute to the high school drop-out rate and the small number of people attending Costa Rican universities. It could be that how the role of education is viewed by governmental leaders may not be the same as by society at-large, and especially by those who are at the lower end of the socioeconomic spectrum. These people may feel that education's purpose is to improve their socioeconomic conditions. However, governmental leaders may view education as a means to improve existing production efforts by producing better educated workers as opposed to better paid ones.

Unfortunately, sectors such as manufacturing, civil service, health care or education may not be able to accommodate everyone, especially those who live and work in rural areas. It could be that these students feel that pursuing education any further than the primary level will not result in improvement of their socioeconomic conditions. Thus, they drop out of school.

Previously in this chapter, Article 77 of Costa Rica's constitution was discussed. The premise of this article was to ensure continuity within and between grades. In other words, the internal structure of primary and secondary schools are established in such a manner that rather than each level being an end in itself, each has become the gate to further education. With a change in the internal machinery, education itself, in terms of end products, also has changes in that "Education in the current mold encourages a white-collar mentality and a contempt for manual labor..." (Thompson, 1986, p. 33). However, as previously mentioned, not all people can be accommodated as white-collar workers in the labor force.

As a result of the educational system there developed a technological pyramid. Its base is composed of the working class. Next come the middle-level technicians, then the professionals, and at the apex are the theoretical scientists. The harmony of the pyramid is a result of the harmony of the organization of the forces of production (González-González, 1984). Production in this sense is not limited only to the industrial or manufacturing sectors. It also includes those who provide health care, civil servants and teachers, as examples. González-González seems to suggest that education plays a role in maintaining a large base of workers to support the activities of the next two levels.

Perhaps this is why Sandoval (1986) characterizes education in Costa Rica as a tool of the political forces. On the surface, she views the educational system as reflecting a political organization that attempts to educate students for life in a democracy that respects individual life and liberty.

Though in her indictment of Costa Rica's educational system Sandoval did not elaborate on the notion of a political system, she does suggest that education is a victim of forces which have political rather than pedagogical goals. For example, she indicates that teaching is excessively bureaucratized and that there is extreme regularization of the Contenidos Básicos. (A description of the Contenidos Básicos will be provided in the following paragraphs).

One cannot help wondering for whom, as opposed to why, was the program of studies designed? Though this researcher does not have sufficient data to quantify an answer (other than the fact that students in Costa Rica's universities represent only 2.2% of the population), it seems that for the most part, this program is designed

for those who will attend a university or college. Given the small portion of the population that do attend college, it is possible that teachers concentrate their teaching to meet the needs of only a very small percentage of their students.

This notion of elitism is proposed by Tobin and Gallagher (1987) after reviewing research that dealt with the practice of science teachers. The idea that Tobin and Gallagher suggest is that science teachers' efforts are geared to the most able students and less so to students who are not as promising. "Reports by Stockton, Jorde, and Gallagher and Tobin showed that secondary science teaching has elitist qualities in which able students are nurtured and less able ones become progressively lost in a tangle of partially understood content" (Gallagher, 1987, p. 384).

Gallagher (1987) , in presenting his idea on elitism, draws mostly from classroom practice. However, it seems that his observation has validity for issues other than classroom practice, such as curriculum development. In other words, if a nation such as Costa Rica develops a program of studies with an eye towards preparing students for the tertiary level, then only those students who can afford to do so will benefit. Thus, elitism becomes an issue for those who establish policy and programs.

If Gallagher's (1987) assessment is correct, then policymakers need to consider the possibility that the design of a program of studies may influence classroom teachers' expectations and energies towards their students.

Contenidos Básicos (National Curriculum)

Contenidos Básicos is the title of the national program (curriculum) for all subject matter. It states exactly what content (facts, principles) students are to learn in each mandated course through high school. It can be likened to a teacher's manual of facts and principles that are to be taught to each student in Costa Rica.

For example, all students who are enrolled in Nivel Diversificado, regardless of whether they are in an urban or rural setting, in private or public school, or are wealthy or poor, will not only take the same courses but study the same content. This includes the science program which is also defined in the Contenidos Básicos.

History of the Contenidos Básicos

The Contenidos Básicos are developed by the Ministerio de Educación Pública and disseminated to all educators of Costa Rica. They were most recently revised in 1987. Prior to 1987, the Contenidos Básicos included objectives and an assortment of suggested teaching strategies. It seems as if the format of the Contenidos Básicos emphasizes the teaching and learning of facts and principles. For example, all references, in the previous version, to other than a particular theme and subject-matter-content objectives, have been eliminated. On the other hand, it could be that the format of the Contenidos Básicos is designed as is because the Ministerio de Educación Pública meant the same to serve solely as a guide for teachers. Therefore, how teachers interpret and adapt this program to everyday teaching would be another important aspect to consider.

The national science program of Costa Rica is called the Contenidos Básicos de Ciencia. It is an example of policy that is prepared and disseminated by the Ministerio de Educación Pública in Costa Rica. The process involved in developing the Contenidos Básicos de Ciencia and what, if any, influences it imposes on science teaching, are the central issues of this study.

As mentioned previously, the Contenidos Básicos de Ciencia is generated by the Ministerio de Educación Pública. It is the national science program taught to all students regardless of where they live, what their economic conditions are, or desire to study.

The only exception is the last year of Agropecuario (vocational/ technical education). Agropecuario students study botany while others must take a biological laboratory course.

A topical outline of the Contenidos Básicos de Ciencia is presented next.

Seventh Year:
- I. The Scientific Method.
- II. The Earth.
- III. The Atmosphere.
- IV. Life (ecological issues).

Eighth Year:
- I. Matter.
- II. Energy.
- III. The Body.

Ninth Year:
- I. Man and Energy.
- II. Exploring Living Things (Anatomy and physiology of single-celled organisms to systems.)

Tenth Year:

Biology (optional).
- I. The Diversity of Life.
- II. The Ecosystem.
- III. Environmental Contamination.

Chemistry (required).
- I. Introduction to Chemistry.
- II. The Atom.
- III. The Structure and Function of the Electron.
- IV. Chemical Bonding.
- V. Chemical Formulas and Changes.

Physics (required).

I. Introduction to Physics.
II. Vectors.
III. Work and Energy.
IV. Application of Forces.

Eleventh Year: Biology (required).
I. Energy Mechanisms of Life.
II. Ecology.
III. Genetics.
IV. Evolution.

Chemistry (optional).
I. Introduction to Organic Chemistry.
II. Hydrocarbons.
III. Organic Compounds and Halogens.
IV. Oxygenated Organic Compounds.
V. Nitrogenated Organic Compounds.
VI. Organic Compounds of Biological Interest.
VII. Organic Compounds of Industrial and Agricultural Importance.

Physics (Optional).
I. Time Reactions of People.
II. Pendulum of Laws.
III. The Telemeter.
IV. Compression and Rarefaction of Air.
V. Velocity of Sound Traveling Through Air.
VI. The Wind Tunnel.
VII. Air Resistance.
VIII. Archmide's Principle.
IX. The Barometer.
X. Thermal Expansion.
XI. Insulation.
XII. Heat Transfer.
XIII. Temperature of Boiling Water.
XIV. Boyle's Law.
XV. Charles' Law.
XVI. Magnetizing Nails.
XVII. Parallel and Series Circuits.
XVIII. Variable Resistance.
XIX. Electricity and Magnetism.
XX. Electromagnetic Induction.
XXI. The Electric Motor.
XXII. Light Reflection.
XXIII. Reflection and Multiple Images.
XXIV. The Corpuscular Model of Light.
XXV. Distancias Focales.
XXVI. The Compound Microscope.

Agropecuario: Offered only during the 11th year of schooling and required for those in the technical branch of study.

I. Vascular Plants.
II. Plan Nutrition, Water and Mineral Salts.
III. Photosynthesis.
IV. Natural Growth Factor of Plants.

Summary

The development of the educational system of Costa Rica sets it apart from its other Central American neighbors in at least two ways. The first is the amount of money that is allotted for education, which, in the case of Costa Rica, is two-thirds of the national budget (Greenwald, 1986). The second is the rich history of continuous attempts made to make primary and secondary education available to all Costa Ricans. As evidence, the cost of public primary and secondary education is constitutionally guaranteed to be borne by the national government.

Unfortunately, the development of this same system has not been devoid of political interference. Legislative action has been taken to try and dilute the amount of impediment that political agendas may carry, specifically, Article 81 of the constitution of Costa Rica. Prior to the passage of this piece of legislation, it seems as if one of the greatest problems was a lack of program continuity contributed to the appointment of a new Ministro de Educación every four years.

Even with the passage of this legislation, the question still remains as to whether or not governmental policies and programs influence science teaching? These policies encompass science curriculum development (Contenidos Básicos de Ciencia), and training of science teachers as parts of the working environment that may prejudice Costa Rican science teachers during actual classroom practice.

CHAPTER III

LITERATURE REVIEW

Development and Education

Introduction

The research questions listed in Chapter I encompass a wide range of issues that are addressed in the literature. These issues are part of general categories, such as education and economic development, education in Latin Americas, science education, educational reform, teaching and learning and social and economic issues pertaining to students. It is important for the reader to realize that these issues stem from the data collected while in Costa Rica. Thus, the following literature review pertains to those issues surrounding the teaching of science in Costa Rica.

Subsequent to World War II, U.S. developmental policy emphasized economic growth. The framework for developmental policy was the Rostovian model. "Development was believed to follow the Rostovian model, where economic growth is the impetus for passage through the various stages of development to a fully modernized society" (Newman and Thompson, 1989, p. 462.)

Economic improvement and the advancement of technology have been the driving forces behind developmental efforts to date.

> In other words, what is now known as neocolonialism is as much a function of economic need and technological power as was classic colonialism. This combination of economic need and technological power has been largely responsible for the peculiar nature of international relations in the modern period (Irele, 1989, p. 127).

Today, as in the past, education is considered a critical component of development efforts. Thus, the role and function of education, as defined by a developing nation, is an important issue to consider. Some educational planners look upon education as a self-improving process. In other words, one obtains an education in order to benefit himself or herself and society (Dewey, 1986). On the other hand, others think of education as a vehicle to prepare youth for work (Schultz, 1975). It is the latter viewpoint which guides most developmental efforts today (Fagerlind & Saha, 1983; Hj, Bakar, et al., 1988).

Human Capital Theory

In general, there seems to be two attitudes one may have about education. One can argue that education can help a person become a better citizen, or that it will help someone be a better worker. Thus, a person's philosophy about the function of education may determine the educational objective(s) that the person envisions. It would also seem that how educational policymakers think about the function of education would also be reflected in the policy and programs they develop. As a consequence, teachers who follow these policies and programs could, wittingly or unwittingly, develop their students according to how the authors view education.

The guiding framework for the development of human resources is human capital theory. "...[T]he human capital theory postulates that the most efficient path to the national development of any society lies in the improvement of its population, that is, its human capital" (Fagerlind and Saha, 1983, p. 17).

The central tenet is that education is not only a consumption good, but an investment in one's future earning potential due to an increase in their possible productivity (Schultz, 1961). "The basic premise of the human capital approach is that variations in labor income are due, in part, to differences in labor quality in terms of the amount of human capital acquired by the workers" (Cohn, 1979, p. 28). Thus, the framework, for the role of education in development, has been to argue that increases in an individual's potential to produce is directly related to education.

Education is acquired through the formal education sector. "Formal education is the principal institution for producing not only values and norms in the younger members of society, but also the skills and division of labor needed for production in a changing economy" (Carnoy & Levin, 1985, p. 3).

Roots of Human Capital Theory

A basis for human capital theory, as well as the equivalent sociological theory of modernization, emanates from structural-funcationalism (Fagerlind & Saha, 1983; Carnoy & Levin, 1985).

> The basic principles of structural-functionalism are quite simple and can for our purpose be stated briefly. In the first place society is seen as a system composed of interrelated parts (religion, education, the political structures, the family, etc.). These parts are said to constantly seek equilibrium or harmony between themselves. The interrelationship of these parts is thought to occur by consensus, and pathological or non-normative events or arrangements are said to produce tension. In such a condition the parts strive to adjust in order to achieve equilibrium (homeostasis) again (Fagerlind & Saha, 1983, p. 14).

The notion of structural-functionalism served as a springboard for two schools of thought. Sociologists were influenced by the modernization theory of development and economists by human capital theory.

> Modernization theory is based on the notion that there is a direct causal link between five sets of variables, namely, modernizing institutions, modern values, modern behavior, modern society and economic development (Fagerlind & Saha, 1983, p. 16). On the other hand, economists...focused upon the productive capacity of human manpower in the development process and in so doing treated the improvement of the human work force as a form of capital investment (Fagerlind & Saha, 1983, p. 16).

It seems that even though there were two schools of thought, one each from sociology and economy, the role of education in attempts to modernize nations was subsumed into theories of modernization. The end result is that modernism and human capital theories have become synonymous.

Alternative Theories

Theories of modernization and human capital gave rise to conflict theories of development pertaining to dependency and liberation. The basis for these theories is the notion of conflict. "...[C]onflicts include the innate contradictions of a social system, revolution, exploitation, colonialism, dependency, struggle for survival, and class and racial conflicts" (Fagerlind & Saha, 1983, p. 19).

Alternative approaches view the role of education as one that serves to maintain the status quo. Rather than viewing education as a means of increasing one's worth, it plays the role of perpetuating a society's social and economic differences because of needs created by modes of production. "Later analysis with functionalists premises (Carnoy, 1974; Carnoy & Levin, 1976a; Bowles & Gintis, 1976) argue that

the structure of social relations in the workplace determines how schools will develop social roles for youth; education develops values and skills to fit social relations outside the school" (Carnoy & Levin, 1985, p. 2).

Dependency Theory

Dependency theorists are concerned with the degree to which poor countries are dependent on rich ones:

> According to dependency theory the transfer of resources can occur in many ways, including plunder, colonial or neo-colonial relationships, or the operations of multinational corporations. Dependency theory provides an alternative to theories of capitalist production. It rejects the linear and progressive view of development and places importance on factors external to society. Furthermore, dependency theory focuses on the process whereby the condition of the less developed regions and countries in the world are seen to be caused by the activities of the rich countries. The process whereby the metropolis dominates the countryside within a country is identical to that which occurs between countries (Fagerlind & Saha, 1983, p. 22).

Liberation Theory

An unequal distribution of social and economic resources is the underlying premise of liberation theory:

> The liberation schools of thought are built upon the conviction that nothing good or profitable can be secured for the poor members of an underdeveloped society without a drastic and radical change in the structure of that society, as well as a broader radical change of the current socioeconomic, political and cultural world order (Fagerlind & Saha, 1983, p. 24).

Education

Lewin (1985) reports the role of education in national development during the 1960s as being dominated by the idea of increasing the productivity potential of the labor force. In the 1970s, Lewin indicated that academics were disillusioned with the

reported lack of success of education in aiding economic development, but politicians, who had to answer to their constituency, continued to push for more education.

According to Moravcsik (1976), education has two functions. "It must impart general knowledge and a broad-minded attitude to the population as a whole, and it must produce creative specialists in various areas of human activity" (Moravcsik, 1976, p. 17).

Moravcsik seems to suggest that the function of education should serve to develop human resources at a level necessary to ensure participation in meeting a nation's objectives for economic improvement through advancements in science and technology. Twelve years later, Moravcsik's thoughts about the function of education were realized on a more global level. This is precisely the role the United Nations envisions for education today (Whiston, 1988). "The development of human resources is accomplished by coordinating education with the needs of science and technology" (Whiston, 1988, p. 1).

In summary, four models of development have emerged over the past few years: Modernization, human capital, dependency and liberation theories. Of these four, human capital theory has had a significant impact in determining the role of education in development. As the most influential philosophical base in development, it proposes the idea of an existing relation between education and productivity.

However, it is not simply any type of education that will afford the greatest opportunities to the future work force. It is the type of education the forces of production desire because it promotes the skills needed for production.

> And though some employers may support the expansion of educational spending, their vision focuses on the resulting production of certain skills pertinent to their industries.

> For example, the high technology industry is pushing for increasing science and math education, but its demands do not discuss who is to get such training (Carnoy & Levin, 1985, p. 147).

It seems as if the scientific and technological sectors of industry have been identified as the areas that need to be improved in order for economic development to take place. Therefore, there seems to be three main areas in development that pivot around education: Economics, science and technology. This is to suggest that people are provided with, and obtain, an education to increase their productivity potential, and science and technology have an important place in the scheme.

Development and Latin America

Historically there is a contrast between the contexts in which development efforts have taken place in Africa, Asia, Europe and Latin America. A reason is that Latin America has been independent for more than 150 years, while most of Asia and Africa have not (Bell, 1989).

Since Latin American nations had been independent for so many years, was the objective of development efforts in this region of the world different from the others? According to Sutton (1989), the answer is no because "Development theory rested on propositions supposedly applicable anywhere, regardless of cultural differences" (Sutton, 1989, p. 53).

Skidmore and Smith (1984) concur by asserting that behind the push towards development, via modernization theory, was the belief that there were little differences between Latin America, Europe and North America. Therefore, up to the 1960"s, development in Latin America was attempted through the ideas of modernism (Muñoz, 1981). There were two

arguments that served as the framework for analysis. One was Rostow's five stages of development and the other was the theory of dualism (Muñoz, 1981).

The relevance of Sutton's (1989) and Skidmore and Smith's (1984) assertion is that it seems as if the world had been divided in half. In other words, in the eyes of developers, the world was divided into developed countries and less developed countries. Therefore, regardless of differences in social, economic and political infrastructures, and money or goods, available to less developed countries, a universal development plan was put into practice. Education was part of this plan and its contribution to the development of human resources was important.

The results of this universal effort met with some failures. Expected changes which were to emanate form development via modernization theory never took place. For example, gaps in income distribution and living standards between rural and urban locales were wider than anticipated (Skidmore & Smith, 1984).

Gallegos (1988) believes that migration from rural to urban areas was the reason educational systems of Latin America have failed. His contention is that people arriving in the urban area put a great strain on the cities' educational infrastructures. Also, the number of people leaving the rural area diminished the political strength of those who stayed behind. Thus, they have not been able to negotiate a better educational experience in the rural area. It was against this backdrop of disillusion that the theory of dependency took root.

Two schools of thought emerged, in Latin America, after the failure of modernization theory had become apparent. One school of

thought focused its analysis "...on the cultural traditions of Latin America and their Spanish and Portuguese origins" (Skidmore & Smith, 1984, p. 9).

The essence of the culturalists' argument was that Latin America was "...a product of a Roman Catholic Church and Mediterranean world view that stressed the need for harmony, order and the elimination of conflict" (Skidmore & Smith, 1984, p. 9).

Another group of scholars maintained the link between socioeconomics and politics. However, they viewed this cause-effect relationship in a different light (Skidmore & Smith, 1984). They argued that there were qualitative differences between Latin America and Europe and North America. Development in Latin America was not viewed as a movement toward independence, but rather as something which created a greater dependency on developed nations (Muñoz, 1981).

In Latin America, education was viewed to be functional. This is to say that education's purpose was to develop human resources so that they in turn could meet the forces of production, which is the premise of human capital theory (Little, 1986). "For at least thirty years most governments in the region (Latin America, author's addition) have argued that activities in education and training should contribute to objectives set forth for employment and should satisfy the requirements generated by technology" (McGinn, Barra, & Harris, 1985, p. 6).

Specifically, in Latin America there seemed to be a greater commitment to expanding educational opportunities than in other parts of the world. "Training systems for the development of specific skills to increase productivity also developed, very rapidly in Latin America, less rapidly in Africa and Asia" (Little, 1986, p. 5). This raises the

question as to what role the Contenidos Básicos de Ciencia (presented in Chapter II) supposed is to play in developing human resources, and what are the consequences of this vision.

Levy (1984) reviewed the works of seven Latin American authors who wrote about educational policy issues in the Caribbean, Central America, Mexico and South America. Levy (1984) identified the following points to be the most salient when these authors wrote about education in Latin America.

1. National development efforts were viewed to not be proceeding at a pace, nor in the direction, desired. As a result, 'In education as in so many other fields, the optimism that characterized modernization theory in the 1950s and 1960s had given away to more somber analyses of the status quo and prospects for change' (p. 153).

2. The question is raised as to whether 'Education shapes politics and society or politics and society shape education' (p. 154).

3. The expected outcome of the role of education was so firmly believed that modernization theory became the only vehicle accepted for development (Levy, 1984).

Levy's (1984) analysis of education in Latin America coincides with Avalos' (1987) ideas on the same subject.

Avalos (1987) analyzed the results of a meeting sponsored by UNESCO in Mexico at the end of the 1970s. In attendance at this meeting were various Latin American Ministers of Education. Though Avalos (1987) did not identify which Latin American Ministers of Education attended, she reports that "Three major issues dominated the discussions and in a way have coloured the concerns of the first half of the present decade. These are equality, quality and relevance in respect of educational provision" (Avalos, 1987, p. 153).

The issue of equality is connected, by Avalos (1987), to efforts at widening educational opportunities. The literacy rates of Latin

American nations and demographics pertaining to student enrollment were the categories the participants used to frame their discussions.

Quality education encompasses teaching, teacher training, and curriculum content. However, it was the issue of curriculum content that the ministers centered around (Avalos, 1987). The curriculum content was viewed as being too general and lacked applicability. The problem is that because teachers are so poorly prepared, they lack the expertise in adapting it to the area in which they teach. Relevance was correlated with the types of education provided and jobs available. Specifically, they were concerned with the high rates of unemployment in the urban sector as compared to the rural sector which had a much lower rate of unemployment. In other words, people were receiving an education that prepared them for scarce urban industrial jobs as opposed to preparing them for work in the rural area where jobs were more abundant.

According to Avalos (1987), these are the issues that will dominate educational policy development for the next 15 years in Latin America.

Science Education In Developing Countries

According to Moravcsik (1976), science education in less developed countries has the function of developing a nation of inquiring minds and sufficient scientists and technologists to meet scientific and technological development.

Adamu (1989) seems to argue along the same lines as Moravcsik when asserting that science education reform of the 1960s and 1970s was directed towards a more utilitarian emphasis on science education.

Along with an emphasis on utilitarianism, science education in developing countries was directed towards economic development and national independence (Adamu, 1989).

Science Education in Costa Rica

Brown (1977) asserts that Costa Rica has for years depended on coffee and bananas. A push towards increasing industry and technology has increased the demand for more technically-oriented students. Brown based this assumption on the idea that "Technological capability is vital to the competitive survival of all industry, particularly that requiring new capital investment" (Brown, 1977, p. 782).

Berty and Esquivel (1985) note that since 1973 there has been an increased emphasis in teaching science in Costa Rica. They also note that there is a desire for the development of new programs, evaluation of these programs and improving inservice opportunities.

Esquivel and Quesada (1985) report the developing, validation and administering of a criterion-referenced test to 1,012 fourth graders, 1,130 sixth graders, 794 seventh graders and 449 tenth graders. Results indicate low science achievement. Rural students had the lowest levels of achievement in science. However, the blame for the overall low student achievement in science was placed on inadequately prepared teachers and existing science materials.

Esquivel and Brenes (1988) replicated results of U.S. studies in a study conducted from 1982 to 1986 by finding males' achievement in science greater than females' for grades 6, 7, 10 and 11. However, females achieved better than males in Spanish for these same grades. They concluded that there are gender differences in the teaching of science in Costa Rica that favor males.

Studies of science education in Costa Rica point to several issues. One is the need for a more scientifically and technologically oriented population. Secondly, the teaching of science has become increasingly more important. Thirdly, the preparation of science teachers and materials are inadequate to meet the scientific and technological needs of Costa Rica. Fourthly, research shows lower science achievement for mostly rural students and females, as opposed to urbanites and males.

These four issues seem to imply that national need and purpose exceed the limits of the educational infrastructure. Another view could be that industries with science and technology needs exceed the ability to accommodate the future work force. From a different perspective, it might be the role of science education, as defined by the Ministerio de Educación Pública (in the form of the Contenidos Básicos de Ciencia), does not have the broad-based applicability as envisioned by those who designed it.

The Mechanisms Involved in Educational Reform

Educational systems are a mirror of society's needs, which are always in a state of constant change. As such, the role of education in a nation changes as national and governmental leaders perceive the need for a different focus. Berg (1989) has identified three differing categories for initiating change in a system. These are centralized planning, framework planning and indicative-planning (Berg, 1989). Thus, the method used to accomplish reform in a system can place decision-making in the hands of a few or can be more broad-based:

> Centralized planning results in directly controlled or 'programme-controlled' activities: there is detailed decision-making at the top level, documented in rule systems which leave only limited scope for local decision-making.

> Framework planning entails 'boundary control', whereby the outer boundaries of an activity are specified. Within these boundaries there is scope for local decision-making. Finally, 'indicative-planning entails 'goal control': activity goals are stated in broad terms and the people controlled by these goals may themselves select the means of achieving them (Berg, 1989, p. 56).

In Costa Rica, educational reformation efforts seem to fall into the category labeled by Berg (1989) as centralized planning. Description of the educational system of Costa Rica in Chapter II has indicated that it is a centralized one. Specifically, the Nivel Central directly controls all changes and leaves very little room for teachers to maneuver.

Young reports that "teacher's role in curriculum development has been studied in two major contexts: the teacher's classroom and the broader organizational setting" (Young, 1985, p. 387). If this is true, then increasing their participation in curriculum development may be a worthy effort. Even though teachers use curriculum guidelines as a major source for decision-making, Young also reports that teachers are ambivalent as to whether or not they participate in the development of curriculum. Therefore, participation may not be a teacher's major concern.

For classroom teachers, perhaps, participation is not as important as feelings of understanding and owning the developed curriculum. "When teachers understand and accept the aims of a program and are provided with the training and resources to implement it, the results are satisfactory for them and their students" (Gallagher, 1987, p. 374).

The ideas posed by Young (1985) and Gallagher (1987) suggest a functional relationship between the educational system, the development of science curriculum, and science teaching in particular. This

further implies that teachers' attitudes, beliefs and classroom practice are affected by forcers that view education as a means to meet the needs of a more scientifically and technologically oriented society. The question then is, what are these forces and how do science teachers respond to them?

This scenario is considered by Berg (1989) as "restricted professionalism." "Restricted professionalism means that teachers and others at the receiving end of reform aims act largely as implementers of central directives. Teachers' autonomy is limited to their actual teaching duties, and the knowledge base they need is therefore confined to a sound knowledge of their subjects and of teaching methods" (Berg, 1989, p. 58).

Regardless of the category of change, as identified by Berg (1989), reforms are not isolated and do not happen haphazardly. Bujazan, et al. (1987) report that educational reforms are dominated by technical and political forces. "We suggest that political processes account for much of the decision-making about setting priorities. We argue that the phenomena would be better described by a third explanatory framework that acknowledges a persistent interplay between technical and political forces" (Bujazan, et al., 1987, pp. 161-162).

These authors also suggest that policymakers make decisions relying on their experience and accepted theoretical norms. The thrust of their argument is what they label as "synthetic analysis" (Bujazan, et al., 1987, p. 162). This view places policy-making in the light of international, national and practitioner interactions with their respective clients. The idea seems to be that change can be accomplished, but not at the expense of those who control it.

Weiler (1989) suggests, as well, that reform takes place in a milieu of political variables. Part of this environment is what Weiler (1989) perceives as "erosions of the state's legitimacy" (p. 291). Therefore, a significant factor to consider about policy reformation is that within the suggested changes are strategies to decrease threats to the authority of the state (Weiler, 1989).

> Considering the key role that educational systems play not only in the inculcation of knowledge, skills and values, but also in the allocation of statuses and their rewards, it is not surprising that attempts to introduce significant changes into educational systems typically generate considerable conflict. An important part of the political calculus of reform policy, therefore, is to contain and manage these conflicts in such a way as to minimize the resulting threat to the state's authority (Weiler, 1989, p. 291).

Besides state integrity, it seems as if maintaining institutional integrity could be an extension of Weiler's argument. For the purposes of this study, the institution in question would be the Ministerio de Educación Pública, and in particular policies and programs, as well as other means used to minimize threats to their authority by teachers.

Teacher Knowledge

The notion of teacher knowledge seems to be divided into two areas. One type of teacher knowledge is what Elbaz (1984) labels as practical knowledge and the other is Shulman's (1986) content knowledge.

Elbaz (1984) asserts that practical knowledge is knowledge gained by experience and theory and when employed it is the last word on what students do in the classroom. In other words, teachers can consider themselves the ultimate agents for developing students in a manner which reflects the values embraced by the leaders of a given society.

This points to the idea that how teachers view their role, and their attitudes, are a result of societal pressures and the type of educational system they work in.

Shulman (1986) notes a need for a greater understanding "...of teachers' cognitive understanding of subject matter content and the relationship between such understanding and the instruction teachers provide for students" (Shulman, 1986, p. 25). In other words, there is a connection between the teachers' knowledge about what they are trying to teach and the instruction they actually give.

Shulman (1986) distinguishes between three kinds of content knowledge. He thinks of them as subject matter knowledge, pedagogical knowledge and curricular knowledge.

Subject matter knowledge is defined by Shulman (1986) as the amount of understanding a teacher has about his/her specialty. Pedagogical knowledge refers to comprehending how subject matter is understood or misunderstood, learned or disregarded. Curricular knowledge is a teacher's understanding of the organization of subject matter facts and processes in packaged curriculum and what are the best ways to present this information.

Shulman asserts the need to look at the issue of teacher cognition more closely. However, he also argues the need to think about another important aspect of this picture. Specifically, the need for policymakers to define what kind of knowledge is important. "The general public and those who set educational policy are in general agreement that teachers' competence in the subjects they teach is a central criterion of teacher quality. They remain remarkably vague,

however, in defining what sort of subject-matter knowledge they have in mind--basic skills, broad factual knowledge, scholarly depth. (Shulman, 1986, pp. 25-26).

This seems to suggest that a teacher's attitudes about teaching and learning can be influenced by attitudes of policymakers and how they envision the same issues. For example, a teacher may have acquired in-depth knowledge of a particular subject matter. Thus, he/she may envision teaching and learning in the same manner. However, the general public and policymakers may determine a need to develop students' basic skills. Consequently, curriculum materials, policy, and inservice programs are developed around the need to develop students' basic skills. These factors, and others, may serve to pressure the teacher to teach in ways different from their original attitudes or ideas. Thus, how they feel about teaching and learning may not be represented by how they actually teach.

Teacher Attitudes and Influences

In their work with elementary and secondary school teachers, Lieberman and Miller (1986) point out that educators are faced with a wide range of problems related to the realities of the classroom. These realities, encountered by the elementary and secondary classroom teachers, force them to make certain decisions regarding the overall grade level curriculum:

> Once can also make a strong case from the literature for reformers to state where the teachers are, understanding the dilemmas that shape their reality. For the elementary teacher, there are issues of more subjects to teach than time to teach them, coverage versus mastery, large group versus small group versus individualized instruction, when to stay with a subject, and when to shift, and how to keep discipline without destroying momentum in the class. For the secondary teacher there are dilemmas rooted in the complexity of the formal and informal system, such as personal versus

> organizational constraints, dealing with the classroom and the school packaging and pacing instruction to fit into allocated time periods, proportioning subject-matter expertise and affective needs in some way, and figuring out how to deal with mixed loyalties to the faculty and to the student culture (Lieberman & Miller, 1986, pp. 97-98).

However, Lieberman and Miller's (1986) work was accomplished in a decentralized system, which suggests that the teachers' autonomy to make decisions would be greater than that of those who work in a more centralized system. As a consequence they do not shed light on how teachers who work in a more rigid organization are affected. The central issue is the notion that teachers, in this system, have the autonomy to make key curriculum decisions which are based on the needs of their classrooms or surrounding communities. In a more centralized system, it could be that the issue of a teacher's autonomy to make curriculum decisions is much more restricted. Perhaps the diversity of learning needs found in their classrooms is not the basis for decisions, but the curriculum itself and education policy from a more centralized authority.

For example, Broadfoot, et al. (1987) compared the ways which English and French teachers conceptualized their professional responsibilities. The thrust of their study was to try and shed light on whether the practice of teachers is influenced by the system in which they work and how. The difference between these two groups of teachers is that the English educational system deemphasizes control at the national level, while the French system emphasizes the opposite.

Two interesting differences between English and French teachers were found by Broadfoot, et al. (1987). English teachers were concerned with disseminating information that fitted students' needs and interests. On the other hand, French teachers were concerned with

teaching the prescribed curriculum. In other words, French teachers adapted to the curriculum, while the English adapted the curriculum to their students.

Besides the issue of curriculum, Broadfoot, et al. (1987) also looked at assessment in both systems. In the English system they found assessment to be less formal than in France. Student evaluation in France was designed to calculate how much of the curriculum students learned. This placed the emphasis on "...mistakes made, rather than on the level of achievement" (Broadfoot, et al., 1987, p. 300).

Costa Rican science teachers work in a highly centralized educational system. For example, the science curriculum and the means of evaluating students' achievement are prescribed by the Ministerio de Educación Pública. The Ministerio de Educación Pública and the public may view the science curriculum as a standard to measure the performance of science teachers. If so, science teachers may feel that their first responsibility is in assuring that students do well on examinations that have to do with the same. Thus, they could be more concerned with the number of correct answers students may have as opposed to their understanding of the science phenomena being examined.

The issues of teacher knowledge and attitudes are, in the end, relegated to how teachers view their responsibilities and how they eventually teach. There are many explanations for the views they form and the actions taken. These reasons could include yielding to administrative pressures or their own failure to change their teaching habits (Farrand, 1988).

Farrand (1988) does indicate that administrative influences (top-down authority, as well as policy and programs) are the most persuasive when teaching occurs. It is how teachers react to

administrative influences that sheds light on whether or not they have had to compromise their beliefs and attitudes (Farrand, 1988). This suggests the possibility that influences within an educational system exist that are designed to maintain the authority of those who administer this system. It could also be that this same policy serves to provide teachers with guidance so they will be more effective. For example, policy that is designed to promote teaching the Contenidos Básicos de Ciencia in a manner considered favorable by the Ministerio de Educación Pública could be an example of such an influence. Thus, the notion of administrative influences would include the socialization that Costa Rican science teachers go through as they respond to a program of study, and the program itself.

Hidden and Manifest Curriculum

An analysis of Erickson (1982), Lave (1985) and Scribner's (1985) work on contextualization was accomplished by Contreras (1986). In this analysis he identified two types of teacher knowledge: academic and social. "They argue that knowledge and learning are socially organized and as such both are contextualized" (Contreras, 1986, p. 2).

Contreras (1986) is implying that there is an interaction taking place in the classroom between the academic and socializing aspects of teaching. The implication is that some teachers are conveying not only what has been deemed important to know but also what type of social behavior students should have.

Shulman (1986) refers to the realities of the classrooms as "...'surrounds' which define, in part, the milieu in which teaching occurs..." (p. 8). He implies that in education the milieu is divided into two parts. The hidden curriculum and the manifest curriculum.

The difference between the two is that the curriculum which he labels "hidden curriculum" has to do with the "...organizational, interactional, social and management aspects of classroom life...," and the "manifest curriculum" is described as "...the academic task, school assignment, classroom content..." (Shulman, 1986, p. 8).

Young (1985) also suggests that, besides the teacher's realities at the classroom level, which must be confronted by the teacher, there are many decisions which teachers must try to fulfill in their classrooms. Thus, the classroom is subject to many forces. Shulman (1986) refers to these forces as a "...multiplicity of layered environments..." (p. 21). Erickson (1986) labels them as "...wider spheres of social organization and cultural patterning" (p. 122).

Everston and Green (1986) have also suggested the presence of such forces and call them "local context as embedded in broader levels of context" (p. 166). This seems to be another way of saying that what eventually science teachers do in the classroom is linked to other forces found in and out of the classroom and educational system. For example, an issue in understanding Costa Rica's educational system is to include a review of its political history. In doing so, one notes the presence of local, national and international pressures that have influenced who is to learn, what they are to be taught, what material is to be used for teaching, and the expected standards which will apply to students. Therefore, it is important to understand how policymakers in a centralized system view teaching and learning. Are their views different from the classroom teacher, and if so, what are the consequences of these differences?

Social Sorting

The notion that teachers may sort students has been advanced by Bourdieu (1974), Thompson (1985), Erickson (1986) and Rhoades (1989). Although all four researchers seem to look at this idea from differing perspectives, they all assert that students are in one fashion or another sorted.

Bourdieu (1974) focuses on the issue of student's social traits acquired in the home and displayed at school. If these traits are not desirable then they serve to single-out the student as not having the correct "cultural capital" (Bourdieu, 1974). The concept of cultural capital was coined by Bourdieu and refers to the cultural background and resources that are a basis for social selection, in the schools and elsewhere (Lamont & Lareau, 1987). Thus, passing on disciplinary knowledge could be an attempt to build on existing desirable, socially acceptable traits.

Thompson (1985) believes that social sorting is a by-product of the organization of the educational system. Conflict arises when the system tries to do good for the order, while trying to promote the local individual. This conflict manifests itself when there is disharmony between theory and practice and it becomes most apparent in the objectives of educational systems (Thompson, 1985).

Following this line of thought, it seems that by increasing educational opportunity for all individuals, there is also a paralleling decrease for certain members of society that does not enable them to take advantage socially and economically.

Erickson (1986) seems to consider that social sorting is in reality a power struggle between teachers and students. Management, or organization of the classroom, is in great part a teacher's reaction to

political issues at the local level and the necessity to convince students of their leadership role (Erickson, 1986). The implication of this idea is that schools accomplish "...social sorting" (Erickson, 1986, p. 134). In other words, students will conform to certain set standards; and if they do not, then they are doomed to fail in school.

The notion of social sorting seems to best manifest itself through socioeconomic status of students. For as Erickson (1986) reports "...it has seemed odd that in developed societies the school failure rate is so high among the majority of the population, who are of working-class or under-class status" (p. 134). This same idea may hold true for developing nations.

Secondary classrooms revolve around specific subject matter and teachers who are specialized in it. "In contrast to elementary schools, discrete secondary school classrooms are organized around discrete subjects, with teachers tending to orient themselves more towards the subject and that academic part of the student" (Rhoades, 1989, p. 11).

Rhoades (1989) implies that teachers and students are connected by the curriculum. In other words, teachers are concerned with passing on their subject-matter knowledge to students. Perhaps by passing on subject-matter knowledge, teachers are in reality acting in ways to preserve the integrity of their discipline. This would suggest that teachers filter available knowledge by providing the students with what is considered pertinent information. To this end, when teachers filter knowledge they may also divide students into those who have 'proper knowledge' and those who do not.

Educational systems are designed to provide students with knowledge which they will need to become successful in a changing

society. Also, because education can be viewed as a vehicle to accommodate change, it has become the ideal that all citizens should strive for. As an example, in Africa "...schools tended to become modern-sector oriented, no longer serving to prepare children for life in their own local communities so much as to fit some children for new roles in the national sphere" (Thompson, 1985, pp. 29-30).

Another way to view this is to entertain the idea that there are key differences between expectations of parents of children attending school and the ability of a country's infrastructure to accommodate these desires (Maddocks, 1984; Fagerlind & Saha, 1983). "National leaders want education to help alleviate problems of unemployment, nutrition, health care, sanitation and housing, but parents see schools as the institution that can aid in escape to the world outside" (Maddocks, 1984, p. 42).

Therefore, in an educational system such as Costa Rica's, where control is in the hands of a few and not the populace at large, how the Minister and others of the Nivel Central view education is important. This is because the educational benefits they hope to reap may, a Maddocks (1984) suggests, not be the same as parents, students and teachers.

Science Achievement and Family Background

A review of literature on the influence of family background and school factors in developing countries was conducted by Fuller (1987) who defined school factors as material inputs like "...the availability of textbooks and school libraries, teachers' school attainment and length of the instructional program" (p. 256). He concluded that school factors, and not family background, significantly

(statistically) explained variance in science achievement for underdeveloped, and not for developed countries. "For industrialized countries, variation in school factors explained small portions of variance in achievement, after controlling for parents' social class. However, in developing countries the block of school factors explained significant portions of the variance in achievement" (Fuller, 1987, p. 257).

Thus, it appears that when studying science education in developing countries (versus developed ones), additional variables should be considered. Per-pupil expenditures, teacher quality, teaching practices and classroom organization, school management and structure are the general areas that influence science achievement in developing countries (Fuller, 1987).

The implication of Fuller's (1987) analysis is that teaching and learning in science can be affected by a wide range of variables. Another way of viewing this is to think of teaching and learning of science as taking place within an aggregation of factors. In other words, imparting and acquiring science knowledge can be likened to a jigsaw puzzle. There are many interlocking pieces that, together, would define science education efforts.

There seem to be two other points implicit in his argument. The first is the notion of equal treatment and opportunity. If family background (which implies social and economic status) is not a hindrance to student achievement in science, then it would seem that providing access to schools with sufficient materials inputs and a high set of teacher expectations would lend itself to providing more students with the opportunity to succeed in science. For a nation

attempting to develop its human resources to meet the demands of science and technology, this would seem to be a worthwhile investment.

A second point is that family background (contrary to Fuller's (1987) assertion) could be as influencing a variable as input material. Students who come from a family background, with the economic means, can afford to send their children to schools that have high per-pupil expenditures, quality teachers and teaching practices, classroom organization and school management, and structure.

Economic, Political, Sociological and Technological Issues

From a broad perspective, forces of production are committed to increasing the productivity potential of their employees. The means to produce centers around two populations: those already in the work force and those who are being prepared to enter the work force.

If those within today's, and tomorrow's, work force do not have the skills necessary to meet current and future demands of production, they must be trained at the expense of the employing institution. In order to decrease the costs involved in training employees to meet their production needs, these forces turn to the educational system for help (Levin, 1978). As a result, education takes on the role of developing students' attitudes and skills that are commensurate with the economic needs of a nation.

To accomplish this, the educational system must develop policy and programs to meet this end (Kumar, Khandelwal, & Simon, 1987). "Education has to be planned in such a way as to develop the available human resources in the best possible way to meet the needs of social and economic development of the country (Ibid., p. 190).

The current emphasis in development is in meeting needs created by the advancement of science and technology. Therefore, it would seem necessary to analyze a nation's science curriculum and science teaching to determine whether science curriculum and teaching lend themselves to the advancement of science and technology. "We feel that science education needs to be reexamined, so that the educational policies and the curriculum can be adjusted to suit the nation's needs with regard to new technologies" (Ibid., p. 197).

Perceptions of future societal needs seem to be placing an emphasis on the type of science education that lends itself to taking advantage of imported and internally developed technology (Khasawnih, 1986). Thus, a new role for education (and by implication science education), in the context of development, needs to be contemplated (Whiston, 1988).

In developing countries, the current and future emphasis for educational planning should be directed towards the coordination of education, science and technology (Whiston, 1988). Whiston argues that scientific and technological development during the last ten years has altered the role of education, especially at the tertiary level. "However, in the past decade or so several major scientific and technological developments have occurred in such areas as micro-electronics (information technology), biotechnology, new materials (especially ceramics and other 'high technology' fields) which have placed new demands upon the education sector at all levels, but especially at the graduate and post-graduate levels" (Whiston, 1988, p. 9).

Whiston (1988) asserts that the world has changed in terms of economy, employment, and an attitudinal gap between the educated and

society as a whole. This "changed educational climate" (Whiston, 1988, p. 10) is the setting in which policy and programs must be planned today to meet future scientific and technological demands.

> Necessarily, this changed 'educational circumstances' affects the various levels of the educational process in different ways. Thus, at the school level, there is much emphasis upon the need not only for more commercial skills (computational skills for the 'new computer age'), but also a 'return to basics' which is envisaged as a necessary readjustment to the more 'literary' educational emphasis of earlier decades (Whiston, 1988, p. 10).

Within the context of coordinating education, science and technology, Whiston (1988) lists 12 areas that should be of concern to educational planners:

1. The education/unemployment problem (Whiston, 1988, p. 27). The various and complicated demands for a work force should be considered.

2. The relevance problem (Whiston, 1988, p. 27). The needs, as well as the structure, of formal and informal economies, need to be analyzed.

3. The pace of change problem (Whiston, 1988, p. 27). Due to the rapidity in which science and technology is changing, developing countries will be working with outdated applications.

4. The need to build in 'transfer of knowledge' (Whiston, 1988, p. 27). Existing labor forces' skills should be developed and then put to use building better and less expensive products.

5. The direction of cause and effect with respect to educational output and industrial development (Whiston, 1988, p. 27). Developing countries are placing formal education in front of industrial development. This leads to inaccurate forecasting of labor needs.

6. Bridge-building and co-ordination between industry and academia (Whiston, 1988, p. 27). A call for an increased analysis of the connection between industry, formal education and society.

7. The location of training (especially at the research or post-graduate level) (Whiston, 1988, p. 27). Encourage developing nations to look more closely at the idea of increasing in-country professional training.

8. The direction of S&T to the most useful and needful areas (Whiston, 1988, p. 27). Rather than developing educational policy along solely technological (industrial) models of development, other models should also serve as a framework for policymakers.

9. Co-ordination beyond the 'national level' (Whiston, 1988, p. 27). Increase cooperation among 'South-South' (Whiston, 1988) by exchanging skilled laborers, developing a basis for education and training resources, awareness of common needs between industrial and rural sectors, and between nations cooperating in developing local skills and technology.

According to Whiston (1988), numbers 10, 11 and 12 refer to the same basic notion:

10. The problem of time-scales (Whiston, 1988, p. 27).

11. The mismatch between the rate of change of educational and training provision in relation to advances in S&T (Whiston, 1988, p. 27).

12. The 'developmental time-scale' viewed against contemporary demographic and social pressures (Whiston, 1988, p. 27).

Summary Statement

In summary, science education is linked to a host of issues, including the underlying philosophy that defines the role of education and science education in a nation. It is this philosophy that serves to frame policy formulation and reformation. Besides affecting policy or reform movements, the role of the science teacher is also influenced in terms of expected outcomes based on policymakers' views on the role of education.

CHAPTER IV

METHODOLOGY

Introduction

In Chapters I, II and III, influences on science teachers' attitudes about the teaching of science were described, including policies disseminated by the Ministerio de Educación Pública of Costa Rica. The purpose of this study was to investigate (1) how education policies in Costa Rica are formulated and (2) how these policies influence practice.

Two questions are then raised, as framed within the stated purpose of the study. First, what role does the Contenidos Básicos de Ciencia play in science classrooms of Costa Rica, in relation to how and what type of science is taught? The second question is in a broader context: What is the Ministerio de Educación Pública's rationale, and what are the mechanisms involved, in designing educational policies and programs in Costa Rica?

As indicated in Chapter II, the Contenidos Básicos de Ciencia contains the national science objectives developed by the Ministerio de Educación Pública to meet the needs perceived by governmental and private sector leaders. This rationale could be in contrast with how science teachers view the teaching and learning of science. Their attitude may be that science teaching should meet the needs of their students and not of the aforementioned forces as represented by the Ministerio de Educación Pública's science program.

Research Questions

There were two major issues which served to focus the research questions developed in this study. One is how educational policies in Costa Rica were formulated and the other is how these policies influence practice. The specific questions were the following:

1. What economic, political, sociological, and technological forces influence secondary science teaching in Costa Rica?

2. How do these forces influence official policy and programs of the Ministerio de Educación Pública?

3. In what way do practicing science teachers adapt to, and adapt, the objectives of the Contenidos Básicos de Ciencia?

    a. What purposes of science instruction are demonstrated and expressed by science teachers?

    b. Are there differences between science teachers in an urban and rural setting and in private and public schools? If so, what are they?

4. Does a vehicle exist through which science teachers can participate in national educational policy decisions?

Use of Interpretive Methods

Interpretive methods of research were used to gather data for this study. Within the framework of interpretive research, Erickson (1986), lists a series of questions that ask about the underlying principles and influences that determine outcomes. This seems to be another way of trying to determine what are the micro/macro linkages which serve to influence teachers of science and the programs they teach..

According to Erickson (1986) micro/macro linkages should be recognized for five distinct reasons: (1) "...The invisibility of life everyday life"; (2) "...the need for specific understanding through documentation of concrete details of practice"; (3) "...the need to consider the local meanings that happenings have for the people

involved with them"; (4) "...the need for comparative understanding of different social settings"; (5) "...the need for comparative understanding beyond the immediate circumstances of the local setting" (Erickson, 1986, pp. 121-122).

Shulman (1986) asserts that interpretive researchers are concerned with identifying forces which play upon a classroom internally and externally. Therefore, for this study, the focus is on surfacing, accounting for, and recognizing the various forces of influence or interplay with which science teachers must contend. This idea is based on the assumption that science teachers must somehow eventually deal with forces which define the setting of their work. Thus, how science teachers view this collection of forces becomes the basis for their reactions, and to understand the dynamics involved in science teaching in Costa Rica, the process needs to be defined through he eyes of the players. However, it should be noted that even though informants provide information based on their own experiences, validity is not assured. This is due to the need for interpretation and explanation by someone other than those who are considered the players.

Erickson (1986) suggests, what validates interpretive research is how accurately one describes what is taking place through the eyes of those committing the action. Thus, the issue of objectivity is an important point to consider. Specifically, the need for objectivity becomes important when one is recording an account of the situation as it has unfolded through the eyes of the actor (Erickson, 1986; Everston & Green, 1986; and Shulman, 1986).

In an interpretive sense, this means that "...an explanation of cause in human action must include identification of the meaning-interpretation of the actor" (Erickson, 1986, p. 127). For this

particular study, science teachers are the principal actors. Practicing secondary science teachers must take the national science program (Contenidos Básicos de Ciencia) and apply it in their classrooms. How they view their actions, and those of the Ministerio de Educación Pública, provide first-hand explanations of their practice.

Collection of Data

In general, data for this study was drawn from three sources. One was publications, including newspapers, official Ministerio de Educación Pública and University documents; the second was science teachers' lesson plans, examinations, and local school site policy bulletins; and the third source of information was obtained via interviews conducted with Ministerio de Educación Pública officials, university teacher educators and administrators, representatives of educational associations, union administrators, Ministerio de Educación Pública appointed science teacher support personnel, and secondary science teachers.

Data was collected via a fixed timetable during the years 1986, 1987 and 1988. Thus, during the data collection phase of this study three trips were made to Costa Rica. Each trip resulted in obtaining written documents and interviews with secondary science teachers and educational leaders.

Due to logistics, a means of establishing a continuous flow of information was necessary. Therefore, during the first trip, a network of people was established. Their function was to collect and forward documents on a continuing basis. Establishing this network facilitated

collecting information found in newspapers and other sources from 1986 up to the writing of this dissertation.

Publications

As indicated earlier, publications from various sources were used. These sources included the following:

- The three main newspapers ("La Nación," "La Republica," and "La Prensa Libre");
- Congressional publications;
- Official documents from educational unions and associations;
- Official publications from the Ministry, such as policy bulletins, statistical data and curriculum programs;
- Procedural documents from the schools in which the 18 science teachers interviewed worked; and
- Lesson plans, teacher-made materials and examinations of the 18 science teachers who were interviewed.

While interviewing the 18 secondary science teachers, various issues would arise that required further clarification. Even though the participants unfolded the story themselves, parts of these stories had to be interpreted and understood. For example, it was felt by this researcher that an understanding of how chemistry, biology, physics and general science teachers were prepared was needed. To obtain this information, "La Universidad de Costa Rica" (prepares Costa Rican secondary science teachers) and "La Universidad Nacional Autónoma de Heredia" (prepares elementary teachers) were visited and a copy of their programs was acquired for analysis.

Interviews

As shown earlier, data were collected form two main sources: people and written documents. Various educators and policymakers were interviewed during June - August, 1986, December (1986) - January

(1987) and in April and May of 1987. Written documents were also collected during these time frames and until the final writing of this dissertation using the network of teachers interviewed. In the following paragraphs a description of the procedures employed for collecting data are described.

Interviewing Strategies

Part of the strategy used to interview science teachers was to divide the time querying them into three sets, labeled Sessions I, II and III. The reason for this breakdown was threefold. First, it was to give the respondent a respite from the intensity of interviewing. Secondly, pausing between sessions allowed this interviewer time to reflect upon, and analyze, each session. Thirdly, a break in between interviews helped both the interviewee and the interviewer note areas needing further exploration.

Another component of the interviewing strategy was to make interviewees feel as comfortable as possible. Establishing a comfortable ambiance was accomplished in different ways. One was to assure all interviewees confidentiality and anonymity. Another was to first engage interviewees in conversation for 20-30 minutes, with the recorder in sight, about familiar and non-threatening matters.

After these initial minutes, the interviewer proceeded to explain the purpose of the interview and to describe the study. Those being interviewed were then encouraged to ask questions. When the interviewee had finished asking questions, and indicated they were ready to begin, the tape recorder was turned on.

Recording Interviews

All interviews were recorded using a standard mini tape-recorder. When the recorder was activated, all interview sessions began with the date and time. Next, all people were asked to state their names and to consent to having their responses recorded. After all of the aforementioned was accomplished, the interview was then begun.

Language of Interviews

Earlier it was indicated that the language used for all interviews was Spanish. This was found to be a key element in gathering data for this study, because none of the participants spoke English with the degree of fluency needed to communicate their rather complex stories. Further, it must be noted that the writer is bilingual and bicultural, providing the language fluency and cultural sensitivity to conduct such a study effectively.

Interviewees

For the purposes of this study, people who were interviewed were divided into those who teach science, and those who do not. Interviews of people who teach science were considered to be central, and labeled as such. This distinction was made because the main thrust of this study was to determine how these persons are affected by the Ministry's policies and programs, in general, and the Contenidos Básicos de Ciencia, in particular.

In Chapters I and III, it was noted that the work of science teachers takes place in a milieu of inter-linked forces that influence science teachers' attitudes and beliefs about the teaching of science. An important part of these forces are people or organizations which are not obviously connected to classroom practice. The role they assume is

behind the scenes or in the background. Therefore, these interviews were labeled background interviews, and included officials from the Ministerio de Educación, university science educators, deans, ex-ministers, principals, and union or educational association representatives.

Central Interviews

Eighteen secondary science teachers were interviewed in Spanish. Of these 18 science teachers, 16 were teaching in a public school and 3 in a private school, including one teacher who taught in both a private and public school. (See Chapter V for a greater description of these people).

Each science teacher participated in three interview sessions. Sessions took place in either the person's home or classroom. As was preferred by many interviewees, most interviews took place in the person's home, in a quiet room. Only the interviewer and the interviewee were present during Sessions I, II and III.

Between each interview session, there was a pause of 2-5 days' duration. This allowed the researcher to mold his investigative activities by giving him the time necessary to analyze each interview session. The result was that later interviews were products of the previous interview(s). An interview session lasted between 3 to 4 hours per individual. The total time devoted to interviewing each teacher (Sessions I, II and III combined) was approximately 9 to 12 hours.

Interview Questions

The following questions were used by this researcher to interview all 18 science teachers. Each set of questions (presented in the

following paragraph) constituted a session. Each science teacher participated in three interview sessions. During Session I, interview questions 1-6 were asked. In Session II, interview questions 7-13, and for Session III, interviewees responded to questions 14-19. Dividing the questions helped to avoid fatigue on the interviewees' part and allowed the interviewer time to analyze each interview.

Interviewees were encouraged to provide descriptive answers to the questions. For example, question one of Session I, if a teacher were to answer "biology," the follow-up question was either, "What do you mean?" or "Describe this program of studies for me."

Session I

1. Which science discipline did you study at the University?
2. Describe the school in which you teach science and the students who attend this school.
3. Describe for me your teaching load in terms of content, number of students, number of hour per day, number of days per year and your relationship with the administration of this school.
4. What types of science tests do you use? Are they made by yourself or developed by Ministerio de Educación Pública (MEP)?
5. How often do you test your students?
6. Why do you test your students?

Session II

7. What types of science textbooks do you use?
8. Do you think it is important for students to learn science? Why?
9. Why do you teach science?
10. What course did the university offer you which helped you teach science? How could your teacher training experience have been improved?
11. How do you assign grades to your students? What are the most important and least important criteria for assigning grades?

12. How much emphasis do you put on laboratory work? How important do you think it is? How many hours of the week do your students spend in the laboratory? How do you assess or grade this activity?

13. What type of help does the MEP offer that facilitates your teaching science? What types of help could they offer that would help you in the science classroom? Besides the MEP, is there any other organization that could help you or does help you?

Session III

14. These are the science objectives of the Contenidos Básicos de Ciencia, which do you consider important? Why? Unimportant? Why?

15. What are the major obstacles that you encounter in teaching science?

16. What do you do to overcome these obstacles?

17. Do you have to complete all of the science objectives? If so, how do you do this? Who assures that you do so?

18. If you could change the Contenidos Básicos de Ciencia, how would you change it? Why?

19. Does an infrastructure exist to accommodate these changes? How practical is this infrastructure?

Background Interviews

As mentioned earlier, background interviews were labeled as such because they served to enrich and complement information obtained from science teachers. The following people were interviewed:

- Two officials from the Ministerio de Educación Pública (MEP);
- Six science teacher trainers from two universities (Universidad de Costa Rica and La Universidad Nacional Autónoma de Heredia);
- A dean of elementary education and one of secondary education;
- Two ex-Ministers of Planning and Development;
- Three school principals; and
- Three union or educational association representatives.

All interviews took place in the person's office and only the interviewer and interviewee were present. The time taken for the interview ranged from 1-4 hours and each person was interviewed only once. Interviews started with an explanation of the study and time allowed for the interviewee to ask questions. As with central interviews, confidentiality in the reporting of data was guaranteed.

Background interviews were of an open nature and did not have a prearranged script. However, these interviews were used as part of the triangulation process regarding science teachers' comments. For example, whenever a science teacher made a comment that had to do with the union, it was double-checked during an interview with a union official.

Thus, using prior comments of science teachers was the only structure provided to the questions asked. Queries were of a general nature and included such questions as: How do you view the educational system in Costa Rica? What problems do you think exist in Costa Rica? What role does education play in the solution of these problems? How are educational policies formed?

Triangulation

Verification of data was accomplished by comparing teachers' comments with their lesson plans, examinations, Ministry documents and information gleaned from background interviews. In other words, throughout the process of interviewing, during the first analytical stage, and the writing of this dissertation, evidence to confirm or disconfirm interviewees' remarks were continually sought.

Recording and Transcribing of Interviews

As indicated earlier, a standard mini-recorded was used to document all interviews. Each audio cassette was labeled with the interviewee's name, date of interview and session number.

Upon returning to the United States, all cassettes were transcribed in one of two fashions, onto a personal computer or by hand. Unfortunately, this researcher lacked a transcribing machine, thus making the process of transferring the session onto a personal computer a difficult task. Given the limits imposed on this researcher by a lack of equipment, use of the personal computer was abandoned and interviews were transcribed by hand.

After an interview was transcribed (either onto a computer or by hand), the tapes and transcripts were turned over to a citizen of Costa Rica who is a native speaker of Spanish, residing in East Lansing, Michigan, for verification of accuracy. Changes, if any, were noted and rectified on the transcripts.

Organization of Data

As previously mentioned, there were two types of data collected: interviews and publications. Data from interviews was organized so that each transcript started with the person's name, pseudonym and demographic data, such as number of years and experiences in teaching, and then the completed text followed. This same procedure was repeated for all three sessions thereby reducing the chances of incorrectly crediting an interview to the wrong person.

Principles of Analysis

Erickson (1986) lists nine main elements which formed the guiding principles for analyzing and eventual reporting of collected data:

1. Empirical assertions;
2. Analytic narrative vignettes;
3. Quotes from field notes;
4. Quotes from interviews;
5. Synoptic data reports;
6. Interpretive commentary framing particular descriptions;
7. Interpretive commentary framing general descriptions;
8. Theoretical discussions; and
9. Report of the natural history of inquiry in the study (Erickson, 1986, p. 145).

The assertions (see Chapter V) developed in this study are based on analysis of data derived from field notes and interviews, as well as official and unofficial reports pertaining top education in Costa Rica.

Another conceptual framework used for analysis was Social Impact Analysis. Social Impact Analysis "...represents an effort to increase knowledge before, during and after development projects and to incorporate the 'target' population into the planning and active stages of the project" (Derman & Whiteford, 1985, p. 1).

For this study, the philosophy of social impact analysis helped to frame the idea that influences could exist which serve to promote or inhibit the community in question, which is science teachers is Costa Rica. Thus, the advantage of the philosophy of social impact analysis is that it may increase one's ability to understand the community one is dealing with by making available to the researcher a broad base of sociological, economic and cultural forces regarding that community. In other words, it can lead to a better understanding of what a community is fully or reasonably capable of doing.

CHAPTER V

DATA PRESENTATION AND ANALYSIS

Introduction

This is a study is of the influences of governmental policies on secondary science teachers as they plan for and carry out teaching. This includes the external forces that influence teachers' decisions and actions and their attitudes and beliefs about science teaching which have been formed through a variety of experiences.

Belief systems of teachers develop, in part, from their family and socioeconomic background. Another portion develops as science teachers progressed through school and university studies. Teachers' dealings with students, administrative policies and education programs are all experiences that contribute, as well, to the development of attitudes and beliefs about teaching. These attitudes and beliefs are what Giroux (1988) refers to as "ideology about schools." How teachers view their purpose and function, and how they actualize science teaching is the product of a multitude of influences. In the pages that follow, I present data from interviews with a group of Costa Rican secondary science teachers.

Characteristics of Participating Science Teachers

Table 1 reflects some of the key characteristics of the 18 secondary science teachers interviewed. Information is reported on four key characteristics of the teachers: science major, years teaching, school assignment (public or private) and locus of work (urban or rural). In order to maintain confidentiality, a pseudonym is

assigned to each teacher. The pseudonyms remain constant throughout this dissertation. The intent of Table 1 is to give the reader an overview of their qualifications, and geographic areas of work. A more detailed description of the science teachers follows Table 1. The reader is also referred to the descriptions set forth in Appendix A (Table 3, Detailed Descriptions of Science Teachers).

Table 1
Characteristics of Secondary Teacher Interviewees

Pseudonym	Science Major	Years Teaching	Public	Private	Urban	Rural
Tico 1	Yes	7	Yes		Yes	
Tico 2	Yes	12	Yes			
Tico 3	Yes	16	Yes	Yes	Yes	Yes
Tico 4	Yes	13	Yes		Yes	Yes
Tico 5	Yes	20	Yes		Yes	Yes
Tico 6	Yes	4	Yes		Yes	Yes
Tico 7	Yes	20	Yes		Yes	
Tico 8	Yes	23		Yes	Yes	
Tico 9	Yes	20		Yes	Yes	
Tico 10	Yes	13	Yes			Yes
Tico 11	Yes	14		Yes	Yes	
Tico 12	Yes	5	Yes		Yes	Yes
Tico 13	Yes	8	Yes			Yes
Tico 14	Yes	18	Yes		Yes	Yes
Tico 15	Yes	13	Yes		Yes	Yes
Tico 16	Yes	9	Yes		Yes	Yes
Tico 17	Yes	20	Yes			Yes
Tico 18	Yes	20	Yes		Yes	Yes

Years of Experience

The mean number of years these 18 science teachers have taught is 14 years (see Table 1). The range of experience was from four years to 23 years (1 teacher each, respectively). Teachers taught for 4, 5, 7, 8, 9, 12, 16, 18 and 23 years (one each, respectively); three teachers for 13 years, and five for 20. With this level of experience, most of the teachers can be considered as being experienced.

Major Disciplines Studied in College

Of the 18 secondary science teachers interviewed, five majored in biology and five had a dual major of general science and biology. Three teachers majored in general science, two in chemistry, one in physics and another in general science and environmental science. Only one participant had a triple major of general science, biology and chemistry.

Public versus Private School Teachers

Of the 18 teachers interviewed, 14 worked in a public school (see Table 1). Twelve were permanent and two were non-permanent public school teachers. (Permanent and non-permanent will be explained in the section entitled "Tenure Issues.") The remaining four are non-permanent private school teachers. (One teacher held two jobs, working full-time in a public and private school.)

Tenure Issues

Public school teachers are assigned either temporarily or permanently to a school. Those who are assigned permanently have a 'plaza,' They are granted tenure immediately upon assignment, the first day. There is a fixed number of 'plazas' in public education

determined by the Ministerio de Educación Pública. Open slots are created through natural attrition. When a teacher who holds a plaza dies, retires or leaves the profession, a vacancy is created. On the other hand, private school teachers have no tenure rights. This is true regardless of the number of years they accumulate in the private school sector.

Conceptual Model Used in Data Interpretation

The preceding chapters suggest three issues: (1) Science teachers may be subjected to many pressures emanating from a variety of sources. (2) These pressures are linked together because they promote a certain vision for education in general, and science education, in particular. (3) The viewpoints of the societal elite may have more influence than students' needs on science teachers' attitudes, beliefs and actions pertaining to teaching.

These issues are embedded in a much broader context than the local science classroom. However, underlying them is the notion that teachers' autonomy to make decisions about science teaching may be imposed upon, limited or eliminated. The framework used for analysis of data is based on the notion that the content of educational policies and programs in Costa Rica, as well as why and how they are formulated, has an influence on science teaching. An important question to be addressed in this study is how restriction of teachers' autonomy occurs.

Forces can be external or internal to a system and they are linked together in many ways. For example, policies or attitudes of a developed country towards a less developed country can influence the educational system of the less developed country. How is the

development strategy and distribution of resources of a less developed country affected by the demands of the developed countries? As mentioned in Chapter III, education is coordinated with the development of science and technology. Do national development objectives influence the formulation of national policy and instructional programs? If so, how are teachers' decisions and actions about science teaching affected? Another linkage could be the needs of pupils in a classroom and the structure of an educational system (policies and programs). How are students who come from special backgrounds (e.g., low socioeconomic status or member of an indigenous group) accommodated for within an educational system?

Craig and Tester (1982) argue that in a community, outside factors may arise in such a fashion that their impact creates a relation between these influences and outcomes. They identify four major sources of impact on a community as economic, political, sociological and technological. In this study, the community in question is the sum of the parts involved in science teaching. This includes leadership or elite of Costa Rica, programs and policies of the Ministerio de Educación Pública, science teachers and students.

A conceptual model was developed based on Craig and Tester's (1982) assertion that outside factors may arise, influencing outcomes. This model was used to interpret data from interviews, observations, publications, lesson plans, examples of examinations and other artifacts that were gathered for this study.

The design was adapted from Craig and Tester's (1982) "Indigenous Peoples: Reassessing Directions for Social Impact Analysis." It reflects the milieu within which science teachers of Costa Rica work.

Accordingly, each box is a summary of a myriad of forces that influence science teaching in Costa Rica.

Explanation of the Conceptual Model

Figure 1 presents a conceptual model of the milieu within which the 18 secondary science teachers work. In Figure 1, the flow of decision is top-down except for how science teaching affects students, which is a two-way flow. As can be noted by Figure 1, there are many

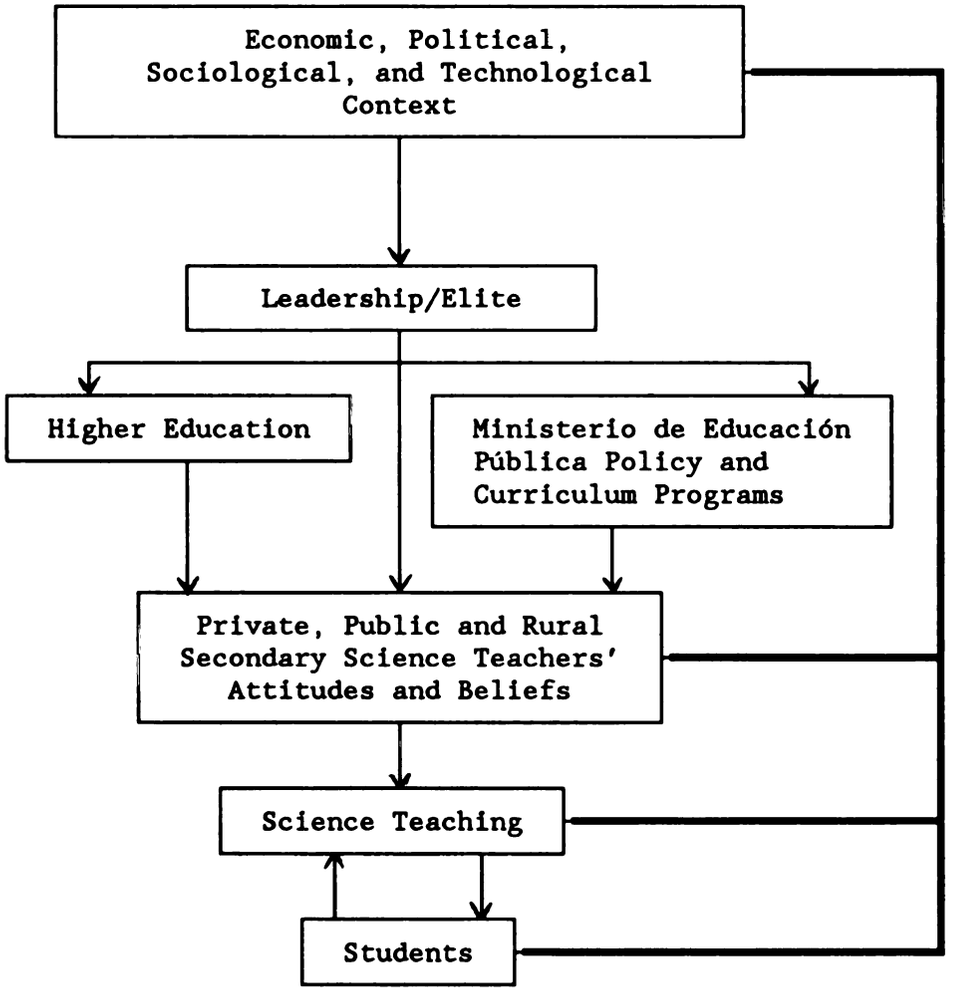

Figure 1
Conceptual Model of Work Milieu of Secondary Science Teachers

economic, political, sociological and technological forces which influence the private and public sector leadership of Costa Rica. These forces also influence objectives that serve as a framework for the Ministerio de Educación Pública or a common view about science teaching, between the aforementioned factors.

However, the Ministerio de Educación Pública's view about teaching and learning science may be different from that of science teachers. Science teachers may not necessarily agree that a connection exists between the needs of their students and the objectives of science teaching and learning as outlined by the Ministerio de Educación Pública. As such, Ministry officials must develop policy to ensure that their learning objectives are being met. Resulting policy may negate science teachers' intents or beliefs, a belief system which, in part, was developed by their experiences at the tertiary level when studying to become science teachers.

The flow of authority in this model is one-way from the top-down. This suggests that science teachers are relegated to a role that limits them only to modes of adopting, and adapting to, the national science program (Contenidos Básicos de Ciencia). The only exception is between teacher and student, where interaction is two-way, thus putting the teacher "in the middle," between the requirements of the Contenidos Básicos de Ciencia and the needs and demands of the students. This tension is exacerbated by several issues which are described in the following pages.

Examples of Costa Rican Economic Pressures

There are many types of economic pressures science teachers must contend with. The distribution of resources in an educational system

is an example. Costa Rican science teachers work in rural and urban areas. This raises the question as to whether or not classroom resources are equally available for those who teach in poor urban and rural areas and in more affluent areas. It also raises the question about differences between private or public schools. Are there qualitative differences in the education of private urban students and those in rural or urban public schools? If so, what are the consequences of these differences? Do teachers in private schools have more control over their environment than their counterparts in urban or rural public schools?

Example of Political Influence

An example of a political influence in Costa Rica is the appointment of a new Ministro de Educación Pública every four years. When this person comes into office, he/she is part of a political agenda, which has a bearing on how the role of education is defined. Does the educational agenda change with each new Ministro de Educación Pública? What are the consequences to teachers if, every four years, the educational system is subjected to modification because of changing political agendas?

Another example is Contenidos Básicos de Ciencia. Does Contenidos Básicos de Ciencia place an emphasis on the accumulation of scientific facts with little emphasis on higher order reasoning skills and applications of scientific knowledge to students' daily lives? If so, this emphasis would be in line with current thinking in development. This is to say that for a nation to realize its potential, it must be capable of harnessing advancements in science and technology via an appropriately skilled work force. How will teachers of science

interpret this message? Did changes in the Contenidos Básicos de Ciencia affect the science teacher and his/her attitude(s) about why science should be taught?

Example of Sociological Influence

Sociological forces also manifest themselves in many forms. For example, in Costa Rica many students leave school at the end of the primary level (Greenwald, 1986), or during the first two years of high school (La Prensa, 1987). Since only 2.2% pursue their education into the tertiary level, how is the majority of students affected by a national science program that seems to be designed for those who are going to go on to college/university?

These questions imply a difference in the expectations that society has about the applicability of education, and those of governmental and private sector leaders. What are the consequences of these differences in expectations?

Example of Technological Influence

Many less developed countries import advanced technology from developed countries. The leaders behind this technology transfer may feel that a necessary ingredient for importing technology is a work force with an appropriate knowledge base. However, it is improbable that all students will become technologically proficient. If the view of the Ministerio de Educación Pública about science education is geared towards fulfilling these technological requirements, how do teachers reconcile this view while trying to meet the needs of all of their students?

Format for Presentation of Data and Analysis

The following outline was used to report confirming and disconfirming evidence.

- An assertion is stated.
- Each assertion is followed by data translated into English.
- Original Spanish text follows English translation.
- Interpretation of data.
- Disconfirming evidence. (Data are also presented in English, followed by the Spanish text.

Personal observations are periodically used throughout this report. Such observations are only in English and are labeled accordingly. When interviews are used to support assertions they are presented verbatim in Spanish and translated into English. No attempt was made to correct the grammar of those interviewed. The English translations, to the extent possible, are verbatim representations of what was said. When it was felt that an explanation of the interviewee's verbal intentions was needed for clarification, the additional information was placed in parenthesis.

English and Spanish Language Issues

Spanish is the language of instruction in Costa Rica. Thus, all information gathered to support assertions was in Spanish because, of the 18 secondary science teachers interviewed, none were fluent in English. The Spanish text and English translation are provided for the reader. There are various reasons for providing both versions. First, it was assumed that many readers of this work do not read Spanish. However, it was also recognized that providing the original Spanish text would allow those who do read this language to confirm translations and perhaps provide further insight. This last idea is

especially important because translating depends not only on one's command of a language, but also on an extensive knowledge of colloquialisms and linguistic subtleties.

Confidentiality

In order to ensure anonymity of the participants, all references to science teachers will be in the form of the article 'he'. Also, whenever a school is mentioned by an interviewee, the name will be replaced by 'A'.

Database and Discussion

In order to guide the reader through an explanation of Figure 1, the following text is presented in a manner that follows the flow of the model. 1 However, the economic, political, sociological and technological issues involved influence each of the major categories of Figure 1. In the paragraphs that follow, it will be demonstrated how these issues influence the leadership/elite of Costa Rica, science teachers' attitudes and beliefs about science teaching and even students.

Private Sector

The Asociación Nacional de Fomento Económico, the voice of the private sector in Costa Rica, believes that education is the prime means through which to improve production and Costa Rica's future.

> In confronting the future, education is the preferred weapon in order to improve our political and economic systems and to strengthen our model of democracy (Asociación Nacional de Fomento Económico, 1986).
>
> Una educación de cara al futuro es la mejor arma para lograr el mejoramiento de nuestros sistemas político y Económico, y consolidar así nuestra ememplar democracia. (Ibíd.)

According to the Asociación Nacional de Fomento Económico, the system of primary and secondary education, as well as university programs for training teachers, need to address six specific areas:

1. Less emphasis on teaching methodology, and more on program content.

2. The number of trained teachers should not be based on the amount of students entering school, but on pedagogical rationale. (Due to a baby boom there was an acute shortage of teachers. In order to meet the demand for new teachers, teacher training programs were shortened. Thus graduates were placed in classrooms without the proper training and credentials. It is felt by the Asociación Nacional de Fomento Económico that the Ministerio de Educación Pública's response to the problem greatly contributed to a decline in the quality of education.)

3. A new government is elected every four years of and the educational system incurs political changes. This results in a lack of continuity and stability in educational programming.

4 Most students are lacking basic skills and cannot communicate effectively.

5. The Ministerio de Educación Pública has become a large bureaucracy resulting in a negative effect on education.

6. There have been too many changes in the educational process based on a series of reforms and counter-reforms that are counter productive to each other. The result is a watering-down of the Contenidos Básicos. Specifically, there is a lack of emphasis on basic skills. Continuous reform movements have also resulted in a de-emphasis of academic discipline (e.g., poor study habits, lack of self-discipline) (Asociación Nacional de Fomento Económico, 1986).

This statement shows that the private sector has determined that education is the vehicle through which to effect their industrial training needs. Further, it is their view that this could be accomplished by making changes in both teacher education as well as the curriculum. But for the Asociación Nacional de Fomento Económico to achieve the changes that are desired, the aide of the Ministro de Educación Pública must be obtained since he has the authority to

initiate changes within the education system. The following is an example of how the current Ministro de Educación Pública responds to their pressures.

Ministro de Educación Pública

Dr. Francisco Antonio Pacheco is the current Ministro de Educación Pública. What role does he envision for education?

> An analysis of our political, educational and production institutes permits us to appreciate the fact that this country has not learned how to deal adequately with the challenge of development in greater measures because we lack clear general concepts about politics, science and technology (La Nación, p. 13, 4 March 1987).
>
> I expect that all of us can participate in converting Costa Rica into being very modern, and well-developed. We can only do this if we make a point of putting education onto the necessary road. (Ibid.)
>
> Un análisis de suestras instituciones políticas, educativas y productivas nos permitirá apreciar que el país no ha sabido enfrentar de manera adecuada el reto del desarrollo, en buena medida porque carece de concepciones claras y de políticas en ciencia y tecnología. (Ibíd.)
>
> Yo espero que entre todos podamos lograr que Costa Rica pueda convertirse en un país verdaderamente moderno, verdaderamente desarrollado y esto solo lo haremos si logramos imprimirle a la educación el rumbo que necesita. (Ibíd.)

The Ministro feels that schooling should play a more dominant role in making Costa Ricans more productive. He also indicates that the role of education has a specific place in developmental efforts.

> Every day, the future is becoming more complicated and only with a rigorous education of high quality, men, our men, our society, can face (the future) and be happy and productive (La Nación, p. 13, 4 March 1987).
>
> El futuro cada día va a ser más complejo y solo con un alto grado de educación de rigor, los hombres, nuestros hombres, nuestra sociedad, se podrán enfrentar a él y seguir siendo felices y productivos. (Ibíd.)

According to Dr. Pacheco, the development of science and technology are two important issues that have been neglected by educators. He is concerned that students are not learning enough science facts. Dr. Pacheco feels this is hampering the country's development efforts.

> Costa Ricans cannot live in ignorance as to how the solar system functions, what are the fundamentals of species reproduction. These are the minimum facts they must know (La Nación, p. 10, 2 March 1987).
>
> The lack of general knowledge has caused great harm to our country if you take into consideration that the majority of those responsible for their own political and economic conditions do not know nor understand the technological processes and the importance that basic and applied science research play in the development of whatever region. (Ibid.)
>
> El costarricense no puede andar por el mundo ignorando cómo funciona el sistema solar, no puede vivir desconociendo cuáles son los processos elementales de la reprodución de las especies, por los menos en sus razgos generales. (Ibíd.)
>
> Esta misión incompleta de la cultura ha causado un enorme daño al país si se tiene presente que la mayoría de los responsables de su condición politica y económica no conocen ni entienden de los procesos tecnológicos y de la importancia que la investigación científica básica y aplicada juegan en al desarrollo de cualquier region. (Ibíd.)

Dr. Pacheco's views embrace three areas. One is the function of education is to promote development. The second is to develop students who are to be potentially more productive workers. Thirdly, he places a great emphasis on the accumulation of scientific facts, perhaps to lend itself to the development of more scientists and technologists. It seems as if the Ministro is recommending coordinating education with the needs of science and technology.

In Chapter III, it was discussed how Moravcsik (1976) viewed the role of science education as developing more scientists and technologists. Adamu (1989) argued that science education was directed towards economic development. Also, Whiston (1989) reported that

education should be coordinated with the needs of science and technology. These three authors suggest that if science education is being directed toward economic development, then the creation of scientists and technologists would have to be one of the foremost priorities.

Whiston (1989) described this need as resulting from economic and employment changes in the world that have created different needs between society and national leaders. It is these changes that drive the development, or reformation, of educational policies and programs. For example, the Ministro de Educación Pública seems to be concerned with reforms that will help Educación Diversificada and Educación Superior (high school/university), to advance education in science and technology.

Also, in Chapter III it was shown that a specific type of education was needed to accommodate industry's future work force needs (Carnoy & Levin, 1985). This suggests that education would need to be planned in such a way so that it could meet industry's needs (Kumar, Khandewal, & Simon, 1987). These two ideas seem to fall in line with Whiston's (1988) description of the role of education as being linked to one of preparing citizens for work as opposed to preparing them to be citizens with the ability to be critical thinkers. Perhaps, as discussed in Chapter III, employers look for ways to decrease costs directed towards the training of employees. Private industry looks toward the educational system to accomplish this task (Levin, 1976).

Another issue discussed in Chapter III is Moravscik's (1976) contention about the function of education as being twofold. Specifically, education should develop basic and specialized skills. The United Nations, as Whiston (1988) reported, suggests the same by

specifically stating that education should be geared towards coordinating the needs of science and technology. As McGinn, Barra and Harris (1985) suggest, coordination of program objectives and teaching is accomplished through the development of policy designed to control teachers' efforts.

As a consequence, students are to learn a type of science based not on their needs, but of those perceived by governmental and public sector leaders. Thus, Contenidos Básicos de Ciencia would be designed to ensure that students learn the 'correct' science. Correct science in this case is the body of knowledge, determined by the Ministerio de Educación Pública, needed to bring students to an intellectual level necessary for the development of science and technology. However, the definition appears to be a narrow one, referring to preparation for university level study of science and engineering, rather than education for a more diverse array of technicians and workers.

Perhaps the impact on local communities of coordinating education to meet these objectives can be summed up by remarks made in interviews with a leading businessman in Limón, Costa Rica (a city on the Caribbean coast) and an Executive Director of Personal for a state-owned company. Limón businessman: "When they finish school all they want to do is to go and work for JAPDEVA (Junta Administrativa para el Desarrollo Económico de la Vertiente Atlántica/Administrative Group for the Economic Development of the Atlantic Slope). No one wants to get involved in working within a local industry." An Executive Director of Personnel put it succinctly: "The problem that we have in Costa Rica is that everyone wants to be educated and no one wants to do the work."

These two comments suggest the possibility of a difference in expectations between the role and function of education, as perceived by governmental and national leaders, and that of community members. Maddox (1984) and Thompson (1985) both speak to this gap between national leaders and community members. Specifically, Maddox suggests that expectations of parents or society are different than that of national leaders. Parents and society turn to education to provide greater economic and social opportunities. On the other hand, Thompson has argued that the current emphasis in education lends itself to developing white collar, as opposed to a blue collar, mentality in today's students. However, in order to meet objectives, which seem to be based on future national economic needs, certain changes must be initiated in the educational system.

Educational Reforms Initiated by the Ministerio de Educación Pública

Education policies and programs in Costa Rica are formulated by the Ministerio de Educación Pública. For example, changes to Contenidos Básicos de Ciencia of Costa Rica are currently taking place, and these are the first changes in 20 years. The changes seem to focus on the Asociación Nacional de Fomento Económico's call for more content and the Ministerio de Educación Pública's request for a more scientifically and technologically oriented student body.

The Contenidos Básicos de Ciencia

The Contenidos Básicos de Ciencia is the mandated science program for primary and secondary schools of Costa Rica and was developed by the Ministerio de Educación Pública. It consists of an outline of science categories that indicate what science will be taught and

learned in an academic year, at a particular grade level, for both primary and secondary levels.

The old official program was divided into four different areas: objectives, topics and content, suggested teaching methods and activities. In the new official science program objectives, suggested teaching methods, and activities, are eliminated. Only science topics, and pertinent content, remain. Science categories are broken down into specific science phenomena. For example:

Science Category	Science Phenomena
La Tierra/The Earth	Capas de la Tierra, Caraterísticas de Cada una de Ellas/Layers of the Earth and Their Characteristics.

The changes are directed towards Educación Diversificada (academic emphasis as opposed to a vocational one), and Educación Superior (university studies), which are considered to be the answers to Costa Rica's future. A future that, in great part, will have been defined by the demands of governmental and private sector leaders.

> However, a distinction of great importance was made at the diversified education level, which is considered fundamental for the future development of the country: academic diversified education and university education (La Nación, p. 10, 2 March 1987).
>
> Sin embargo, se hizo una variante de gran importancia en el nivel de educación diversificada, el cual se sustituyó por dos niveles educativos, que se consideran fundmentales para el desarrollo futuro del país: la educación diversificada académica y la educación universitaria. (Ibíd.)

Although the Contenidos Básicos de Ciencia had not changed in the last two decades it was amended in 1987. The change was based on concerns expressed by the private sector, as represented by the Asociación Nacional de Fomento Económico, governmental leaders, and the

public, about the caliber of education that students were receiving. They became alarmed by poor student performance, in Spanish and Mathematics, on a nationwide test administered by the Ministerio de Educación Pública.

As a response to this situation, the Ministerio de Educación Pública mandated that a nationwide test would be administered to all students on a yearly basis. Another fact, although unrelated to poor students' test scores, is that all teachers of Costa Rica, by law, must at a minimum teach what is written in the Contenidos Básicos de Ciencia for the science discipline they are teaching at a particular grade level. Thus, the use of a yearly test, plus mandating that teachers must teach the Contenidos Básicos de Ciencia, has served to influence science teachers in the following way.

Some science teachers teach the Contenidos Básicos de Ciencia because they must do so. In the following example, a public school science teacher felt it necessary to teach all of the science content mandated for the year only because he had to.

> It is to say that I feel that I follow the program because I am obligated by them. I do not like it, the written part is an obligation for me. It is like playing the role of a secretary I say (Tico 9).
>
> Es decir yo siento que yo hago el programa porque me obligan. No me gusta, es para mí una obligación la parte escrita, como la parte de secretariado digo yo. (Ibíd.)

The evaluation of students on a nationally administered standardized test also influenced science teachers. (Unfortunately, at the time of the writing of this dissertation the national test had yet to be initiated. However, science teachers were very aware of the threat of this test, when developed, because it will be used to test their students on how well they know the national science program.)

> In the seventh year and in the tenth and eleventh, I use the official program of the Ministerio de Educación Pública, the minimum contents. Yes, the pink one. This is the guide because the students of the fifth year (last year of the Nivel Diversificado), will be evaluated this year. They are going to be given an examination by the Ministerio de Educación Pública, even though the test is not a requisite for graduation, but we have to do it. In the future years of it looks like they are going to demand this in order to get a high school degree (Tico 6).
>
> En sétimo año si, y en décimo y undécimo uso el programa oficial del Ministerio de Educación Pública que nos dan los contenidos mínimos. Sí, el folleto rosado. Esa es la guía porque los muchachos de 5 año van a ser evaluados en este ano. Van a presentar un examen ante el Ministerio de Educación Pública, aunque no es requisito para graduarse, pero tienen que hacerlo. En los años futuros parece que si lo van a exigir como requisito para obtener bachillerato. (Ibíd.)

Since it was reported the test will be based on the Contenidos Básicos de Ciencia the results could be used for a dual purpose. One is to determine how proficient are students in science, and the other is to measure the effectiveness of science teachers.

This means that science teachers would be held accountable in two ways. One is through their students' performance on the national science test. The other is the pressure science teachers may feel recognizing that a positive or hostile public attitude towards them depends on their students' test scores. This suggests the existence of many reasons, other than education policy, that have a bearing on whether or not science teachers comply with the Contenidos Básicos de Ciencia.

For instance, there is the issue of school accountability. Specifically, the school's administration is held responsible by the Ministerio de Educación Pública for teaching the Contenidos Básicos de Ciencia. Because the school's administration is held accountable, so are science teachers.

> Yes, each department was given a copy of the minimum content. This content has to be finished because it is this content that the student will be evaluated on and it is through this content that the high school is held accountable to the Ministro and the Ministerio de Educación Pública (Tico 5).
>
> Sí, a cada departamento se le dio un contenido mínimo, ese contenido se tiene que cumplir porque sobre ese continedo el muchacho va a ser evaluado y sobre ese contenido el colegio tendrá que rendir cuentas ante el señor ministro y ante el Ministerio. (Ibid.)

The organizational makeup of schools can also be considered an influencing factor.

> In the public schools one has to comply with the national (science) program, because these schools are departmentalized. Teachers of each subject matter makeup a department and that department has a department head who takes his/her guidance from the administration (of the school). As a result, this person takes charge and reports to the principal (whether teachers are in compliance or not). I suppose that the principal then passes this information on to the regional director (Tico 5).
>
> En los colegios oficiales hay que cumplir con el programa nacional, porque en los colegios hay departamentos. Los profesores de cada materia forman un departamento y ese departamento tiene un jefe que depende de la dirección del colegio. Entonces tiene que llevar el control e información al director y supongo que el director al supervisor regional. (Ibid.)

Budgetary constraints and making schools seek permission for out-of-classroom activities are other forms of control the Ministerio de Educación Pública employs to ensure there is no deviation from teaching and learning the Contenidos Básicos de Ciencia. A science teacher from the rural area of Puntarenas gives us an account of how.

> When we want to go on field trips, authorization is denied us by the administration because there is no money in the budget nor any provided by the Ministerio de Educación Pública because they do not consider field trips as studying and they are opposed to them. They even disseminate bulletins that prohibit this type of activity (Tico 2).
>
> Cuando queremos hacer excursiones al campo no recibimos autorización de la administración porque no hay dinero, ni del Ministerio de Educación Pública, porque este

> considera que la excursión no es estudio y se openen a ellas, incluso mandan circulares diciendo que están prohibidas. (Ibíd.)

This researcher was not able to obtain a copy of the aforementioned bulletin. However, the reported existence of these documents, mandating teachers to complete the Contenidos Básicos de Ciencia and a national test soon to be administered to all students, does suggest the Ministerio de Educación Pública is concerned that their views about teaching science may be circumvented by science teachers. The implication is that they recognize their views about science teaching may not necessarily be those of science teachers. Specifically, the Ministerio de Educación Pública may view science teaching as being the acquisition of facts. One the other hand, science teachers may want to teach science in a way that takes into consideration the students' own surroundings.

Data gathered in this study indicate that the terminal objectives, determined by the Ministerio de Educación Pública, and the private sector, are in contrast with how science teachers view the teaching and learning of science. Specifically, secondary science teachers of Costa Rica may view the teaching of science as a way to provide students with an array of skills that may be of use to them in their respective communities. However, developing skills commensurate to a community's needs may not be as desirable as the development of skills to develop science and technology. The following section speaks to this issue.

Attitudes and Beliefs of Science Teachers About Science Teaching

The Ministerio de Educación Pública established national testing, and a system of supervision, that influence science teachers' autonomy to make decisions. These influences are controlling mechanisms that

engender compliance with the Contenidos Básicos de Ciencia. As a consequence, science teachers' decisions about science teaching and learning are influenced by education mandates in the form of laws and policy reminders, and withholding money for out-of-classroom experiences. The effect of these influences on their attitudes and beliefs becomes evident when a discrepancy is noted between teachers' expressed goals for teaching science and their actual teaching plans. This suggests that teachers' beliefs and attitudes about science teaching can be influenced by factors other than students' needs. For example, regardless of the intent or beliefs of teachers about science curriculum, there is strong evidence that most comply with Ministerio de Educación Pública policy related to the Contenidos Básicos de Ciencia.

The attitudes and beliefs that science teachers expressed to this researcher are that science learning should be practical and fun. For example, science learning should be practical is the message from a science teacher with nine years of experience in both urban and rural public schools when asked why students should learn science.

> Science is something someone should learn because it helps them in life and complements the social aspect of their life. It help you in life because it has many practical applications even, for example, in the kitchen. The students in school they have to learn why water boils more rapidly in a covered pan as opposed to an uncovered one. This helps them at home, it helps them in many areas not only in class. Certainly in class one goes into depth about the basic principles that are applicable. For example, the pressure cooker, what are the principles involved? Why shouldn't the covered pan be opened all at once, and things like that which also deal with safety in the house. Some are practical and are useful to everyone, not only to those who study science (Tico 16).

> Ciencia es una cosa que alguien debe aprender porque se ayuda mucho en la vida y se complementa la vida social. Te ayuda en la vida porque tiene muchos conocimientos y prácticas, a veces incluso por ejemplo en la cocina. Los alumnos en la

> escuela ellos tienen que aprender porque hierve más el auga en una olla tapada que una olla destapada. Eso le sirve en la casa, le sirve en muchas partes no solo en las clases. Claro en la clase ya profundizan los principios que hay allí. Por ejemplo la olla mágica, que principios tiene, que no se debe abrir de un solo golpe y cosas así que también son seguridad de la casa. Algunos son prácticos y a cualquiera le sirven, no solamente que estudien ciencia. (Ibíd.)

Some felt that learning science helps students appreciate nature and the world they live in.

> My objective is that the student understand the study of science allows them to relate better to the world in which they live. To understand surrounding phenomena that occurs on a daily basis and to comprehend that he can become happier. The second objective is that the persons needs to feel good about him/herself and that they must understand themselves. I always tell them that this is the only way to be; i.e., to respect oneself very much because no one respects what they don't know. One can instill fear in one's self as well as a lot of other sentiments, but never respect. By studying five years of science they are going to better understand the world in which they live as well as themselves. This is how they will benefit, by enjoying life more (Tico 8).
>
> I even tell them sometimes when they are bored in the waiting room of the dentist and there is a pretty plant, if one does not know something about botany they look and say look at the plant. But if one knows something about botany they then can entertain themselves, by observing the shape of the leaves, the edge of the leaves. One can also mentally enter the leaf and imagine the structure of its cells and if one knows a little about physiology, how they function. One goes into the world of the plant so deeply that when the secretary calls you it is difficult to get yourself out of the plant. You have passed an enjoyable time, but maybe the most important think is to realize the significance of using what you know. (Ibid.)
>
> Mi objetivo es que el alumno comprenda que el estudio de la ciencia lo lleva a relacionarse mejor con el mundo en que él vive, a comprender los fenómenos que le rodean, lo que le ocurre todos los días y al comprenderlo el pueda ser más feliz. El segundo objetivo es que la persona tiene que sentirse bien consigo mismo y de esta forma llegar a quererse, respetarse mucho porque nadie respeta lo que no conoce, le pueden infundir el miedo y un montón de sentimientos pero que nunca respete, así que ellos a traves de la ciencia en los 5 años, van a aprender a conocer el mundo en el que ellos estan y a disfrutar más de la vida, e inclusive yo a veces les digo que cuando uno esta en el consultorio de un dentista aburridísimo esperando, de repente

> hay una planta muy linda, si uno no sabe nada de botánica la ve y dice mira una planta, pero si uno sabe algo entonces se entretiene, le ve la forma de las hojas, el borde de la hoja y ya puede uno con la mente meterse adentro de la hoja e imaginarse cómo son sus células, si sabe un poquito de fisiología como estan trabajando, entonces uno se va metiendo en el mundo de esa planta y cuando ya le llama la secretaria hasta la cuesta a uno abstraerse de la planta y ha pasado un rato agradable, y tal vez lo más importante es encontrar en las cosas cotidianas el gran significado que tiene de los conocimientos que ocupa. (Ibíd.)

Others felt that science should be taught so that students can incorporate the knowledge in their daily lives. A science teacher with 12 years of experience in the Western rural side of Costa Rica made the following remark.

> Much of the phenomena that students study is not that important because it is a duplication of effort. Some of them, like the study of the earth, can be found in Social Sciences. (This person is referring to the Social Sciences Contenidos Básicos). The objective for teaching science is that the student is able to use his/her basic knowledge in daily life (Tico 2).
>
> Muchos de los aspectos que se estudian no son de mucha importancia, como que se duplican los temas. Pues algunos se ven en estudios sociales, como el estudio de la tierra. El objetivo de la enseñanza de ciencia es que el muchacho ponga en práctica los conocimientos básicos en la vida diaria. (Ibíd.)

On the other side of the country, in Limón, a science teacher says the following:

> Another thing that is important is that the knowledge imparted by it (science) it will allow them to better comprehend the world that surrounds them. Another aspect is that we are going to dispel many prejudices, superstitions and beliefs. Another aspect is that they will be able to resolve their own problems because of the experience they will acquire working in the sciences (Tico 10).
>
> Otra cosa importante es por los conocimientos que eso les va a proporcionar, que les va a permitir comprender mejor el mundo que los rodea. Otro aspecto es que vamos a combatir muchos prejuicios, supersticiones, creencias. Otro aspecto es como ellos puedan resolver situaciones con la experencia que adquieren por la forma de trabajar aquí en ciencias. (Ibíd.)

Teachers also talked about the need for students to be able to relate what they are taught in science to their everyday world.

> The objective of science (teaching/learning) should be to develop future citizens who have a scientific understanding of the world that surrounds them. In the (teaching) science program it is important that the student recognizes that science is like a set of knowledge based on the scientific method (Tico 9).
>
> El objetivo de ciencia debe ser el formar un muchacho del futuro que tenga un conocimiento científico del mundo que lo rodea. En el programa de ciencia es importante que el muchacho conozca la ciencia como un conjunto de conocimientos pero con un método de trabajo. (Ibíd.)

It does not seem to matter if the science teacher is from a public or private school, works with a poor, middle-class or rich student population, or if the school is located in an urban or rural setting, they all say that learning science should be enjoyable and practical.

Differences Between What Science Teachers Say and What They Plan

There is a difference between what science teachers profess that they would like to do, and their actions. When their lesson plans were analyzed they reflected very little, if anything, of what they were saying. For example, all of the public high school science teachers interviewed stated that they took into consideration their students' experiences when planning to teach science. A teacher from Limón gave the following account of what he takes into consideration when he plans.

> When it comes to plan my work I have to take into consideration the family situation because there are many incomplete homes (single-parent homes), another thing to consider is that some of my students are very poor, their parents do not work and they must earn their money by being a street vendor (Tico 15).
>
> A la hora de planear el trabajo yo tengo que tomar en cuenta la situación familiar, pues muchos hogares son incompletos, por otro lado son estudiantes muy pobres, pues sus padres no tienen trabajo y se dedican a vender en las calles. (Ibíd.)

However, lesson plans reflected only the Contenidos Básicos de Ciencia. Some science teachers actually went so far as to xerox the Contenidos Básicos de Ciencia and turn that in as lesson plans. Perhaps because they know that teaching the Contenidos Básicos de Ciencia is what is expected of them and this is their manner of presenting evidence of completion to the school's administration.

> In the beginning of the year the teacher develops a plan and gives it to the administration who I suppose evaluates it. The annual plan includes all of the objectives (Tico 4).
>
> El profesor hace un plan de trabajo a principio de ano, que se entrega a la dirección y se supone que el control lo ejerce la dirección. El plan anual incluye todos los objetivos. (Ibíd.)

Classroom observations were infrequent in this research effort because, with the exception of four teachers, the others chose not to invite this researcher into their classrooms. In spite of this limitation, those times this researcher did observe science teachers in the classroom, they were adhering strictly to the format of the Contenidos Básicos de Ciencia. These actions seem to suggest that perhaps science teachers are responding to administrative pressures rather than how they would like to see science taught.

The idea that teachers conform to programs and policies seems to be related to Farrand's (1988) suggestion that administrative influences (top-down authority) are the most persuasive when teaching occurs. However, Farrand also suggested the notion that how teachers react to administrative influences can be indicative of whether or not they have had to compromise their attitudes or beliefs. Thus, how teachers view the Contenidos Básicos de Ciencia is an issue that needs to be established in order to help unravel a very complex issue. For example:

> They are on paper. It is impossible to finish all of the objectives even though one goes very rapidly with the materials (Tico 9).
>
> Estan puestos en el papel. Es imposible cumplir con todo los objetivos aunque uno desarrolle muy rápido la materia. (Ibid.)

This comment underscores some of the resentment and frustration science teachers feel when dealing with the Contenidos Básicos de Ciencia. The following teacher's quote is another example of these same feelings.

> I have had to change the way in which I teach chemistry because (students) are learning very slow. Also, the text that is required by the Ministerio de Educación Pública is bad. It is very theoretical. The (laboratory) exercises need to be developed by the teacher. There are ten books for 150 students. It is ridiculous! Because of this the teacher has more work. They (the teacher) must dictate the material or work in groups (with students). The politics of this school is to teach the most important parts of the (national science) program and not all of it. The Ministerio de Educación Pública thinks in the same manner (Tico 15).
>
> Yo he tenido que cambiar la forma de enseñar química, porque el aprendizaje es muy lento, inclusive el libro de texto que pide el Ministerio de Educación Pública, que es muy malo, muy teórico, las prácticas tiene que crearlas el profesor, son 10 libros para 150 estudiantes es un ridículo. Por eso el profesor tiene más trabajo pues le toca exponer la materia o trabajar en grupo. Inclusive la política de la institución es dar los contenidos más importantes del programa, y no cumplir con todo el programa. El Ministerio de Educación Pública también tiene esa política. (Ibid.)

In addition to feelings of resentment and frustration, another teacher seems to suggest a sense of alienation from the Contenidos Básicos de Ciencia, a loss of authority to make decisions about teaching, and that classroom practice is being influenced by school material and the environment of the school. This following example demonstrates how restricted a teacher can feel.

> I try to vary the manner in which I teach so that they (students) do not become bored. For example, when I teach the theory I repeat (the lesson) because they do not learn the major points the first time. I do not like being a

> traditionalist by dictating the lesson and hope that students understand me (Tico 4).
>
> If one gives them theory they study and memorize it for the examination. Four to five days later you ask them the same thing and they know nothing. This is what I have been doing. (Ibid.)
>
> Yo trato de variarles mucho la forma de enseñar, para que ellos no se aburran. Por ejemplo, cuando les doy teoría les repito varias veces porque ellos no tomen los puntes de una sola vez. No me gusta ser tradicionalista y dictar la materia y lograr que los estudiantes lo entiendan a uno. (Ibíd.)
>
> Si uno les da la teoría, la estudian, se la aprenden para el examen, la recitan en el examen, y a los cuatro o cinco días usted les pregunta y no saben nada. Eso es lo que yo he estado haciendo. (Ibíd.)

One of the issues that is interesting to note, in the above example, is the teacher does not seems to like how he is teaching science but feels compelled to conform to Ministry expectations. This indicates the possibility that his attitudes and beliefs about science teaching have been influenced by a sense of a lack of autonomy. These influences are varied and originate from many sources. For example, another teacher felt the Contenidos Básicos de Ciencia is politically oriented.

> The national programs do not meet the needs of Costa Rica. Like everything else, the national programs of education are part of national politics. They are constantly changing because every four years of there are political changes and every four years of they (national programs) change. The national (science) plan is programmed in the same manner. It is changing constantly. These, the objectives that are in these plans, do not coincide with the national reality. Definitely they do not coincide. From there (the Ministerio de Educación Pública) everything filters down (Tico 12).
>
> Los programas nacionales no llenan las necesidades de Costa Rica. Como todo los programas nacionales de educación estan relacionadas con la política nacional estan cambiando constantemente en cuanto la política que esta porque cada cuatro años hay cambios y cada cuatro años hay cambios políticos. El plan nacional igualmente esta programado debajo eso. Hay cambios constantemente. Este, los objetivos

> que estan en esos planes no coinciden con la realidad nacional definitivamente no coinciden. De alli viene todo por abajo. Un desastre. (Ibid.)

Science teachers' reactions to the Contenidos Básicos de Ciencia seem to be rather negative for a variety of reasons. However, what seems to be common amongst these teachers is the notion that how they believe that the Contenidos Básicos de Ciencia has been influenced by factors beyond their control. For example, some feel that there is too much to be taught, implying a desire for more depth and less breadth in the format of the Contenidos Básicos de Ciencia. Others indicated a lack of ownership, and as suggesting a desire for greater participation in curriculum development. Still other science teachers implied the Contenidos Básicos de Ciencia was subject to political influences that resulted in a conflict between the objectives of governmental leaders and national realities.

Evaluation as an Influence

The country of Costa Rica has an extremely elaborate evaluation system. The various components of this plan include an Evaluation Committee in each school, a mandated format for examinations, control over the time they are to be administered, guaranteed testing rights of students, as well as specifications of the content students can be tested on. Science teachers do feel the weight of such a strict evaluation system and respond accordingly.

> We cannot develop an examination that consists solely of higher order thinking questions because they must pass through an evaluation committee, made up of various teachers as well as follow a particular format. There has to be a test section (true/false, multiple choice, fill-in-the-blank) which is the bulk of the examination and an essay question (Tico 5).

> Un examen de solo razonamiento no se puede hacer porque los exámenes pasan a un comité de evaluación, formado por varios

profesores, y estos exámenes deben seguir un patrón, tiene que haber una parte de test que es a mayoría y una parte de desarrollo. (Ibíd.)

Evaluation Committee

There is an Evaluation Committee in each school whose members are made up or rotating faculty. The function of the Evaluation Committee is (1) to ensure that Ministerio de Educación Pública evaluation policy is being carried out, (2) to monitor grades and (3) to serve as an ombudsman for students.

The following are excerpts of a policy bulletin from School 'A' by the Evaluation Committee. It is intended as an example as to how an evaluation committee functions at a school. All teachers are obligated to meet the procedures as set forth in this policy notice.

3) On the recommendation of the Ministerio de Educación Pública's Department of Evaluation the following is ordered:

a) In reference to short quizzes this Committee solicits from each teacher one copy of each test along with the answers two days before the date it is scheduled to be given.

b) Revisions of midterm and final examinations will be done accordingly:
   i. The department head will review a working copy of the examination.
   ii. The department head will review and sign a stenciled copy of the examination.
   iii. The Evaluation Committee will review and sign a stenciled copy of the examination.

c) When a teacher misleads a student with a question, he/she cannot acknowledge this or give complete credit, because besides not being authorized to do so, such conduct goes against the examination itself. The item in question should be given again to the student and he/she should be notified eight days before (bulletin from School 'A').

3) Por recomendación hecha en el Departamento de Evaluación del M.E.P. se dispone lo siguiente:

a) En cuanto a las pruebas parciales, este Comité solicita a cada profesor una copia de cada examen con las respuestas; dos días antes de la fecha programada.

b) La revisión de los trimestrales se hará de la siguiente manera:

   i. El coordinador del Departamento revisara el borrador del examen.

   ii. El coordinador del Departamento revisara y firmara el examen en el estencil.

   iii. El Comité de Evaluación revisara y firmara el examen en el estencil.

c) Cuando un profesor extravía la prueba aplicada a un alumno, no se le puede reconocer o regalar el valor total del mismo, porque además de no estar autorizado, tal conducta va encontra de los principios de la evaluación misma. La prueba en cuestion se le debera aplicar de nuevo al educando, con un aviso de ocho días naturales. (Ibíd.)

If a science teacher wants to have an examination, he would have to (1) write the examination in compliance with the allowable format, and (2) submit the examination to his/her department head and the committee. Both of them would review the examination for format compliance. If all is in accord, the teacher is given the go-ahead, if not, what is not in compliance needs to be rectified.

In the next quote a private school teacher explains what he must undergo before giving an examination.

> In every high school there is an evaluation committee composed of teachers from the various departments. When I develop my examination I give it to the science department head and she suggests some changes which we discuss. After this the examination goes on to the Evaluation Committee (Tico 14).

> En todos los colegios hay un comité de evaluación, integrados por profesores de todas las especialidades, entonces yo hago mi examen y se lo doy a la directora del departamento de ciencia, y ella sugiere algún cambio y lo discutimos, luego el examen se va al comité de evaluación. (Ibíd.)

Examination Format

All examinations must employ a certain format. At a minimum, all examinations must contain an essay question (mandatory) and one each of either a true/false, multiple choice, or fill-in-the blank for a total of three different types of questions.

> Generally speaking, a section of the examinations has a test (true/false, multiple choice or fill-in-the-blank), another part is essay which I apply a lot of importance to because I can ask useful questions here (Tico 4).
>
> Generalmente los exámenes tienen una parte de test, una parte de desarrollo a la que le doy mucha importancia porque aquí yo pregunto cosas prácticas. (Ibíd.)

Rights of Students

Students have certain rights guaranteed by the Ministerio de Educación Pública regarding examinations. No student may be given a surprise examination. They must be given eight days notice of a pending midterm or final examination and four days for a short quiz. Short quizzes may not take longer than 30 minutes and no more than three a day may be given. Only two midterms or finals may be given in any day. Any material not identified in the advance notification cannot be included in an examination. All individual examination results can be contested by a student to the school's Evaluation Committee.

How Do Teachers View Evaluation?

Science teachers view examinations as a way to control their students, in the sense that tests can be used to force the student into memorizing the Contenidos Básicos de Ciencia. For example, a Puntarenas teacher's views regarding examinations reveals that he uses

them as a means of coercing the student into learning the Contenidos Básicos de Ciencia.

> Examinations require that the student constantly reviews the material. Because here the problem is that the students copy and copy (lessons from the chalkboard) so much that they forget the material because it does not interest them (Tico 2).
>
> Los exámenes permiten que el muchacho esté constantemente repasando la materia, porque aqui el problema es que los muchachos copian y copian, y olvidan la materia porque no les interesa. (Ibid.)

It could be that the evaluation system imposed upon teachers serves to stifle their usage of examinations as a diagnostic tool. Also, the framework for evaluation could have been deliberately established, by the Ministerio de Educación Pública, as a way of keeping teachers from deviating away from the Contenidos Básicos de Ciencia.

Recent Changes in the Evaluation System

One of the recent changes in the evaluation system is the weight of short quizzes in determining a student's semester grade. In the past, the short quiz could only account for ten percent of a student's final grade. This ten percent also included class participation, laboratory work or homework. When the change occurred, the two short examinations or short quizzes were allowed by the Ministerio de Educación Pública to represent as much as 25% of the student's final grade. This change simply reinforced existing teacher attitudes regarding the function of examinations.

> Teachers greeted this change enthusiastically.
>
> The short examination obliges students to study every day (Tico 16).
>
> El examen corto los obliga a estudiar todos los días. (Ibid.)

Teachers' Beliefs about Examinations versus How They Use Them

The following is an example of how a teacher contradicts his own attitudes about evaluation. A rural teacher from Limón with 13 years of teaching indicates that examinations should be used as diagnostic tools.

> An examination is a thermometer that measures how much a student has learned (Tico 19).
>
> El examen es un termómetro que mide el aprendizaje del estudiante. (Ibíd.)

However, in the next few seconds this same teacher contradicts himself and looks upon evaluation as a method to control the student.

> For me, evaluation is very important because in this way, the student is obligated to study (Tico 10).
>
> Para me es muy importante evaluar porque así se obliga al muchacho a estudiar. (Ibíd.)

The teachers' use of examinations to make students study and the emphasis of the Ministerio de Educación Pública on the Contenidos Básicos de Ciencia appears to be a force that drives teachers.

> I give students exams first because I must oblige with the rules, on the other hand, the student would not study if it would not be for exams. For me, the exam is a form of control (Tico 5).
>
> Yo le doy exámenes a los estudiantes primero porque hay que cumplir con el reglamento, por otro lado el muchacho si no es por el examen no estudia. Para mi el examen es una forma de control. (Ibíd.)

Some teachers seem to resent the detailed evaluation system and even consider it to be an insidious plot of the Ministerio de Educación Pública.

> I am under the impression that the Ministerio de Educación Pública has deliberately plotted to try and make the teacher and student enemies. I believe that the Ministerio de Educación Pública did this so that they may regulate evaluation and the work of the teacher (Tico 17).

> Yo tengo la impresión que el Minsterio de Educación Pública se ha encargado de poner al estudiante al lado del profesor como enemigos. Yo creo que el Minsterio de Educación Pública hizo esto para regular la evaluación y el trabajo de los profesores. (Ibíd.)

In the final analysis, teachers have very little control in terms of evaluation in the classroom. However, the small amount of control they do have is guided towards controlling students and not diagnosing and helping them.

Preparation for the university is one emphasis resulting from this reformation. Whiston (1988) discussed this same idea, indicating that rapid growth of science and technology places demands on education, at all levels, but more so at the post-secondary level (see Chapter III). Another is the emphasis on the acquisition of facts. A consequence of these emphases could be that teachers would place a priority on knowledge needed to pursue tertiary studies because the Contenidos Básicos emphasizes academics, not practical knowledge. Science teachers emphasize the type of science background necessary for entry to study science or technology at a university.

Thus, science teaching is influenced by material issues, and also by students' chances of success one they graduate from high school. Taking a step backward, one can also see influences on science teaching in how the Ministerio de Educación Pública manages educational resources, and how governmental and private sector leaders manage socioeconomic differences of the population of Costa Rica. The Ministro de Educación Pública's vision about the role of education seems to be in accord with that of the private sector, which includes the elite and conservative factions of Costa Rica. Suggestions by both the Ministerio de Educación Pública and the Asociación Nacional de Fomento Económico for improving Costa Rica's educational system

(programs, policy and teacher training) imply a desire to develop human resources, i.e., scientists and technologists, by developing a more scientific, technological and cultured population.

In summary, science teachers' attitudes about teaching science appear to be influenced in many ways. Lieberman and Miller (1986) suggested that teachers must contend with a wide range of problems based on the needs of the community and the classroom. It is these problems that influence their decisions about the classroom. However, they were referring to teachers who worked in a less rigid organization than that of Costa Rica. Broadfoot, et al. (1987 did compare teachers who worked in a less rigid system (English) with those of a more rigid one (French). They suggested that it is the organization of the system which influences teachers. Specifically, they indicated that the amount of control of an educational system at the national level will influence teaching in many ways.

In Chapter I, the idea of teachers serving as educational agents was discussed. Research by Barnes (1979) indicated that some teachers viewed their roles as being literal interpreters of curriculum, while others transmitted ideas that were considered pertinent to students' experiences and realities. Erickson (1986) also suggested the notion that teachers can serve as agents used to impart specific kinds of knowledge to students.

Erickson (1986) and Barnes (1979) seem to place teachers in one of two spheres: Conformists or non-conformists. Conforming teachers would then serve as the vehicles through which the ideals of governmental and industrial leaders are transmitted. Thus, linear concepts of curriculum development (theory to objectives of curricula)

place teachers in a position that they are "...seen not in terms of agency but as facilitator, enactor or conveyor; in short, he is seen as an instrument" (Elbaz, 1984).

On the other hand, non-conforming teachers would be viewed not as agents, but working counter to the ideals of governmental and national leaders.

In this study, evidence from teachers' lesson plans indicated they were literal interpreters of the Contenidos Básicos de Ciencia. In other words, they stayed within the guidelines of the Contenidos Básicos de Ciencia. However, as will be discussed later, there were teachers who did not always strictly comply with policy related to the Contenidos Básicos de Ciencia.

It seems that the design of the Contenidos Básicos de Ciencia, as well as policies developed by the Ministerio de Educación Pública, also place some limitations on decisions a teacher can make about science teaching. Perhaps this is what Berg (1989) refers to as "restricted professionalism." In other words, teachers should only concern themselves with teaching and become more subject-matter proficient. Not allowing science teachers more opportunities to make decisions about the Contenidos Básicos de Ciencia may be, as Wilder (1989) suggests, a way in which the state is able to maintain its authority, i.e., by minimizing dissension. On the other hand, it could be as McGinn, et al. (1985), suggest--the Ministerio de Educación Pública is, through policy, attempting to match education with technology and employment opportunities.

Data provided earlier included a description of the type of reformation advocated by the Asociación Nacional de Fomento Económico (voice of the private sector) in 1986. Summarizing, the Asociación

Nacional de Fomento Económico desired changes in education of science teachers that would result in de-emphasizing teaching methods, and emphasize learning of basic knowledge skills. Along these same lines, the Ministro de Educación Pública, in 1987, redesigned the Contenidos Básicos de Ciencia.

This is an important point to consider because planning and dissemination of education policies and programs in Costa Rica are centralized. Centralized planning lends itself to direct control of programs and teaching (Berg, 1989). This would place teachers in the role of implementers with very limited decision-making opportunities. Perhaps because the locus of control is at the national level, combined with science teachers' perceptions as to how little authority they have, may result in teachers saying one thing and teaching in a totally different way.

A call for action on the part of the Asociación Nacional de Fomento Económico, and the specific changes advocated by the Ministro de Educación Pública could be interpreted by secondary science teachers as a mandate to prepare students for tertiary studies. This raises the possibility that science teachers, when contemplating the issue of how to match subject-matter applicability with their students' needs, experience a conflict between the same, and a politically-driven national framework (objectives) for science teaching. Thus, the issue becomes one of conflict between what science teachers believe, and what they actually do.

The result is that a style of teaching is adopted more in concert with fulfilling what the Ministro de Educación Pública feels is important, as opposed to how and why science teachers perceive students should be engaged in the learning of science. Thus, what eventually

takes place is that teachers' efforts are geared towards teaching the Contenidos Básicos de Ciencia, and not exploring scientific understanding with students, or helping students acquire practical scientific knowledge.

Teachers give a variety of reasons for their actions. Some center around problems generated by the low socioeconomic conditions of their students and shortcomings, they perceive, within the educational system. For example, science textbooks at the secondary level are scarce, or non-existent, in public schools. When books are available, they are considered inadequate for use. As a result, some science teachers use this as an excuse to have towards copy and memorize science facts written on the chalkboard. Consequently, towards spend many hours copying what is on the board and very little time, if any, exploring science.

> In general terms we have to present the subject matter in an expository manner because there are no textbooks. Furthermore, the administration of High School 'A' does not like when one charges students for ditto materials (Tico 5).
>
> En términos generales a los estudiantes hay que darles la materia con el método expositivo pues no hay libro de texto. Además la directora del colegio de 'A' no le gusta que uno le cobre a los estudiantes por material poligrafiado. (Ibíd.)

Private school science teachers are able to require their students to buy science textbooks. Even so, they still acknowledge that science teaching takes on the form of a lecture and subsequent memorization of science facts.

> A problem (that we have) with teaching is that teachers place great importance on theory, specifically memorization and not on reasoning (Tico 8).
>
> Un defecto de la enseñanza es que la gente le da importancia a la teoría y no al razonamiento, es decir a la memoria. (Ibíd.)

When some teachers do have the opportunity to work with textbooks they still do not adopt a different style of teaching. For example, a Ministerio de Educación Pública sponsored program organized through the Centro Universitario Para El Mejoramiento de Ciencia (CUMECI) provided paperback science books for students in a few pilot public schools. Rather than use these texts as a way to investigate science, some teachers still chose a didactic style of teaching.

> I used textbooks last year because I worked with CUMECI and this program has textbooks that are sold to the student for 25.00 colones. These paperback books are used for every unit and the student works alone. But here we have a problem because some teachers do not explain the material to the students (Tico 1).
>
> Yo usé textos el año pasado porque trabajo con CUMECI y este método tiene sus propios libros que se le venden al estudiante por 25.00 colones. Estos folletos se dan por unidad, y el estudiante trabaja solo, pero aqui hay un problema pues algunos profesores no explican la materia a los estudiantes. (Ibíd.)

In some ways, the Ministerio de Educación Pública's actions contribute to teachers maintaining an expository style of teaching. Instead of encouraging teachers participating in the CUMECI Program to use texts in ways that allow exploration of science, the Ministerio de Educación Pública evaluates science teachers' performances by administering a test to their students, based on recall of science facts.

> Teachers who work with CUMECI use the science textbook because the Ministerio de Educación Pública is going to give (the students) an end of the year examination which will be used to evaluate teachers and students. They did this last year and the results were a huge disaster (Tico 1).
>
> Profesores que trabajan con CUMECI utilizan el libro de ciencia pues el Ministerio de Educación Pública va a hacer un examen a final de año para evaluar tanto a profesores como a los alumnos, el año pasado lo hicieron y resulto un fracaso rotundo. (Ibíd.)

The Ministerio de Educación Pública's use of an examination based on the CUMECI textbook, to evaluate student performance and consequently teachers' ability, more than likely is another reason why some teachers do not bother to explain the material. In all likelihood, these teachers are more concerned with how well their students will do on the test because their teaching success is equated with favorable testing scores. In other words, examinations are driving science teaching efforts as opposed to helping students understand science phenomena.

Still another point of view is the notion that secondary science teachers are victims of their own formal pre- and inservice professional training. In other words, teachers could lack the knowledge needed to teach science for understanding and use because these ideas and techniques were not emphasized at the university level, and by the Ministerio de Educación Pública. In the latter case, this is manifested by the Ministerio de Educación Pública not providing inservice programs that stress methods pertinent to understanding science as well as exploring the differences between the understanding and memorization of science phenomena.

There are other excuses that science teachers use for a more didactic style of teaching. For example, an unwillingness by the Ministerio de Educación Pública to print more chemistry textbooks and students' inability to purchase them from another source is used by the following teacher as the reason he teaches in an expository manner.

> The chemistry book that I mentioned to you earlier was printed by the Ministerio de Educación Pública and cost 40.00 colones. (The Ministerio de Educación Pública) no longer prints this book. Any other book costs 800.00 to 900.00 colones and we know that the economic level (of the students at this) school prevents us from asking them (to purchase

one). As a consequence, the teacher has to mostly use an expository (approach to teaching) (Tico 18).

El libro de lo que yo te habalaba, de química que editaba el Ministerio de Educación Pública, contaba 40.00 colones, ahora ya no lo volvió a editar, y cualquier libro cuesta 800.00 o 900.00 colones, y nosotros sabemos que al nivel del Liceo 'A' no lo podemos pedir. Entonces el profesor tiene que trabajar mucho expositivo. (Ibíd.)

As suggested earlier, besides the issue of textbooks, there are other factors which contribute to this teaching approach. Teachers felt that their low salaries, and the economic conditions of their students, prohibit them from assuming a style of teaching other than a didactic one.

A person earns 20,000 (colones per month) and they reduce his/her salary by 4 or 5,000 (colones) to pay for social benefits. They are left with 15,000 (colones). How is he/she going to make do with 15,000 (colones).

As a result, he/she cannot purchase books for themselves to study nor (purchase) and bring materials to the school. The children also cannot (provide materials) because they have the same problem. Therefore, one works purely with the chalkboard. You (the teacher) give and give, and they (the students) write and write (Tico 5).

Un hombre que gana 20,000 pesos y que de esos le rebajen 4 o 5 mil pesos porque vienen todas las cargas sociales que le rebajan y le quedan 15 mil pesos que va alzar la carga un hombre con 15 mil pesos, entonces no puede comprarse para estudiar en esos libros, por lo tanto él no va a llevar materiales al colegio, los entonces se trabaja a pura pizarra, usted tome y tome y escriba y escriba y nada más. (Ibíd.)

A lack of time to explore science is another excuse used by teachers.

In this high school we limit ourselves to (only) doing what the Ministerio de Educación Pública asks us to do. Because of a limited amount of time, you cannot explore any of the contents in great depth (Tico 1).

Nosotros en el colegio nos limitamos a cumplir con lo que el Ministerio de Educación Pública pide, porque no se puede profundizar mucho en un contenido pues no alcanza el tiempo para cubrir el resto. (Ibíd.)

One teacher critiqued both the educational system and his colleagues. He feels that the system restricts choices that teachers can make and that this is used by them as an excuse to make science teaching easier.

> Logically, it is the system's fault. Today's teacher is a part of this system and the national programs. I believe that a teacher is much like a horse with blinders who cannot see to either side. As a result, it is easy for the teacher to take the (national science) program, open it and give only its contents. Because this is what is asked (of him by the Ministerio de Educación Pública), nothing more. The other way, looking and looking to see what can be done with (the program) is the hardest. The majority of elementary and secondary teachers take the easy way out (Tico 3).

> Es culpa del sistema lógicamente, ahora el profesor esta en ese sistema de los programas nacionales. Yo digo que el profesor es como un caballito que le tapan los ojos para que no vea hacia los lados y entonces para el profesor es muy fácil a escoger ese programa, abrirlo y dar eso, porque eso es que se le pide y nada más. Lo más difícil es lo otro, ver a ver que se puede hacer con eso y la mayoría de los profesores y los maestros le gustan lo más fácil. (Ibíd.)

Whatever the reason, science teachers spend very little time in applications of science phenomena. This raises several questions: Do teachers instruct in an expository manner because they perceive that the educational system and the economic conditions of their students handicap them? Is it the fault of the Ministerio de Educación Pública when it uses the results of student performance on national examinations to evaluate teachers' classroom accomplishments? Or, do they simply find the job of teaching science is less demanding when one's instructional style is expository?

Comments of science teachers interviewed provide evidence to support the notion that teachers feel pressured because of their students' economic conditions, salaries, lack of textbooks, testing and Ministerio de Educación Pública policy. Also, a study of science classrooms practice by Gallagher (1986) indicates that teachers do look

for ways to make the teaching of science easier. Thus, along with all of the reasons given by teachers, one other may be that they use these problems as excuses to teach science in the least demanding way. Unfortunately, it seems as if teachers expend energy in their concern about issues beyond their control and fail to act in areas where they can make a difference, such as condemning the lack of textbooks, while failing to teach science using the plants, rocks, and other resources from the environment that are free.

Use of the Laboratory to Explore Science

Besides how they teach, science teachers' use of the laboratory was considered an indicator as to whether or not rote learning was encouraged and applications of knowledge and development of critical reasoning in science discouraged. The laboratory was considered important because this setting can be used to help students develop understanding, application and higher order reasoning skills.

Almost all science teachers interviewed did not use the laboratory to explore science phenomena. One of the chief reasons they did not do so was because the structure of the Contenidos Básicos de Ciencia does not mandate a laboratory course until the last year of high school. This is the year when all students in Educación Diversificado (high school) must take a biological laboratory class. It was only during this year that some teachers would bring their students to the laboratory on a regular basis. However, for most teachers though that year was determined by the Ministerio de Educación Pública as one to study science phenomena in the laboratory, they spent much of the year simply teaching more content.

Therefore, even though work in the laboratory is required in the last year of secondary studies, science teachers use a lack of laboratory facilities as an excuse for not doing so.

> In the case of my high school it is difficult to work in the laboratory. If you want to do (laboratory work) you use the tables in the classroom. This is why equipment must be furnished (by the Ministerio de Educación Pública) because if not the school is left without accoutrements. I think the majority of teachers eliminate the laboratory because (a lack of supplies) makes it more difficult for them. Still another drawback is the laboratory equipment we have is minimal and very simple (Tico 16).
>
> En el caso de mi colegio es difícil trabajar en el laboratorio, si quiere hacerlo lo hará en las mesitas de la clase. Por eso tiene que ver equipo que aporte porque si no se queda el colegio sin equipo. Luego la mayoría de los profesores eliminen el laboratorio, porque es más difícil para uno. Otra desventaja es que el equipo de laboratorio que uno tiene es mínimo y sencillo. (Ibíd.)

The following teacher's quote gives another version of the same story.

> In reference to laboratory equipment, some high schools have a little, others nothing, and still others, a lot. Nobody bothers themselves with the laboratory (Tico 9).
>
> En el equipo de laboratorio, algunos colegios tienen poco, otros nada, otros tienen mucho y nadie se preocupa por el laboratorio. (Ibíd.)

These two teachers point to a lack of facilities and equipment as reasons why they do not use the laboratory. They also imply that part of this unwillingness may have to do with the amount of work involved teaching in a laboratory setting.

In the next quote, a public school teacher explains how the use of the laboratory differs between private and public schools.

> Laboratory time is only given if the high school has the necessary equipment to do so. I would say that private high schools and public high schools close to the capital, have the necessary equipment for work in the laboratory. As a consequence only those students who graduate from these high schools to go the university with experience in laboratory

> work, the rest of the students know nothing about this area because they have only received classes on theory (Tico 13).
>
> Las horas de laboratorio se dan solo si el colegio cuenta con el equipo para hacerlo. Yo diria que los colegios privados y algunos colegios públicos de la capital, disponen de materiales para hacer prácticas de laboratorio. Entonces solo los estudiantes graduados de estos colegios llegan a la universidad con conocimiento sobre práctica de laboratorio, el resto de los estudiantes no conocen nada sobre el tema, solo han recibido clases teóricas. El Ministerio de Educación Pública no da dinero a todos los colegios para que tengan su equipo de laboratorio. (Ibid.)

Visits to a private school supported this teacher's claims about the same. Students were not only engaged in laboratory exercises, but the facilities themselves were filled with equipment. Again, this points to the suggestion that private school students receive more opportunities to learn science than those in public institutes.

A Public School That Does Use the Laboratory Extensively

Apparently there are some schools where laboratory experiences are provided even though they lack equipment. In Limón, students are given two years of laboratory work.

> In tenth and eleventh grades they go into the laboratory to do exercises, but the laboratory is rudimentary, it does not have the necessary equipment (Tico 10).
>
> En décimo y undécimo pasan al laboratorio a hacer prácticas, pero el laboratorio es muy rudimentario, no cuenta con el equipo necesario. (Ibid.)

What is interesting about this teacher's comment is that it suggests that science teachers from this school may not entertain the idea of using simple, homemade equipment in their laboratory. As mentioned earlier in this chapter, perhaps these teachers have not been provided an inservice program that shows them how.

However, there was one public school whose science teachers reacted in ways very different from all of the aforementioned schools.

Even though they had very little laboratory equipment, they did not feel deterred from providing learning experiences that explored science theory. This school found ways to adapt to their economic situation. For instance, in spite of a dearth of materials, this public school teacher from Limón indicated that he and his colleagues have adapted by using student-made materials, as well as the school's natural surroundings, as a means to circumvent their lack of resources.

> Notwithstanding and in spite of those obstacles in this work we try to take maximum advantage of the limited resources that are available. However, as you can observe, this high school was established 14 years of ago and the only thing in this laboratory are those pipettes and probes. It is a very humble laboratory which has been developed by the students. Due to their own initiative they have brought many materials (Tico 17).

> We do not have many teaching resources at our disposal. This is to say resources that are more technical. Since we cannot obtain these instruments, we have opted for a concept a little more realistic to our situation. We take advantage of the resources that are outside (the classroom), and practically give all our classes (laboratory) outside. (Ibid.)

> No obstante a pesar de esos obstáculos que en este trabajo y se trata de sacar el máximo provecho dentro las limitaciones en cuanto a recursos. Sin embargo usted puede observar que este colegio va para catorce años de estar fundado y lo único que nos queda es un laboratorio de fisica que son esas pipetas y probetas, y tienen una forma muy humilde el resto ha sido elaborado por los estudiantes, y cantidad de materiales que ellos han traído aqui, en última instancia nos hemos hecho a la situación de la falta de recursos didácticos, de diapositivas, digamos recursos más técnicos. Básicamente podemos tener una concepcion un poquito más real, y sacarle provecho a los recursos de allá afuera. (Ibíd.)

Perhaps secondary science teachers need to learn how to be more resourceful at their local school site. However, even though some teachers would be able to adjust to a lack of resources, it takes much time and energy to do so. These preparations may be so demanding that time is taken away from teaching.

Teachers' Attitudes about the Laboratory versus Their Actions

Most of the teachers interviewed spoke of the importance of the use of laboratory investigations to explore science. Though they spoke of it importance, their explanations of how the laboratory should be used belie their words. For example, the attitude of a teacher from Puntarenas regarding science learning indicates that the laboratory is a vehicle used to familiarize students with instrumentation rather than science exploration.

> The principal objective is to integrate the student into the study of science. One of the ways of doing this is through the use of equipment in the laboratory. It is important to make sure that the student understands that learning to work with the equipment is more important than the individual (Tico 14).
>
> El principal objetivo es integrar al muchacho en al estudio de la ciencia. Uno de los objetivos es el trabajo de laboratorio realizado en el equipo, y es importante lograr que el muchacho entienda que el trabajo en equipo es más importante que el individual. (Ibid.)

There is no mention that the laboratory can be used for other than equipment familiarization. Perhaps the two vignettes that follow may help the reader understand how science teachers design laboratory experiences for their students.

Observations of Two Laboratory Exercises

This researcher was able to observe two teachers during a laboratory period. The following vignettes describe what was observed.

Vignette Number One

The public school is located in one of the poorest sections of San José. While waiting for the students to file in, a survey of the room was accomplished.

The laboratory consisted of standard black-topped tables with built-in gas nozzles used to connect Bunsen burners. Each table had six stools. Cabinets, filled with preserved specimens, lined the walls.

Students came into the room quietly and immediately went to their assigned work areas. Roll was not physically taken by the teacher. He took roll mentally. This was made apparent when he indicated that a few students were absent. Once seated, the students started talking amongst themselves. When the teacher started to explain what they were going to do that day, they all quieted down immediately.

Students were given a handout which explained the laboratory exercise they were to engage in that day. The experiment had to do with acids and bases. During the instruction phase of the lesson, the teacher stressed to the students that they were to carefully observe any changes and, in a like manner, record their data. Students were admonished to follow carefully the recording procedures established by the teacher. Students were then set on their own.

After a few minutes the students were apparently finished with the experiments. This became obvious because they started writing and ignored the equipment. As students were recording their data, they started working in groups or pairs. Several times this researcher walked around the room observing what they were recording, as well as eavesdropping on their conversations. It was their conversations that were the most revealing as to the type of laboratory skills that had been emphasized in this classroom.

Students were only interested in making sure that they recorded the 'correct' science observations. Questions such as, "What goes on here?" and "What color did it turn?" are examples of their attempts to

follow the teacher's procedures. These questions could be considered indicative that students were being prompted to think more about their observations. However, in this case, students' questions were of a procedural nature as opposed to questioning what they were observing, or understanding the meaning of their observations.

If their answer was different from that of another student in their group, they would change it to match the others. Students questioned their own results only because the others in their group had a different answer. Not once did students engage in any discourse which could be perceived as a challenge to the others' conclusions nor about the experiment itself.

Vignette Number Two

This event also took place in a public school, but on the outskirts of San José. The students were seniors and the class was the biology laboratory given to students their last year. Because of the time this researcher was invited to the classroom, students were already sitting on their stools listening to the teacher take roll.

The room was set up in the same way as the laboratory in Vignette Number One. The only exception was the presence of a laboratory assistant who was going to do the experiment for the students.

The teacher explained to the students that this experiment would provide them with proof that green plants have chlorophyll. No other comment was made by the teacher and the students did not ask any questions. A signal was given to the laboratory assistant to begin the demonstration and the teacher stepped aside.

Equipment necessary for the demonstration had already been set up. As the laboratory assistant lit the Bunsen burner all student fidgeting

and noise stopped. The pupils started gazing intently at the beaker, waiting to see what was going to happen. When the alcohol turned green, the teacher explained to the students that the green was chlorophyll and that this was proof that it was present in green plants. Students were then asked to record their observations and the assistant started taking away the equipment.

Students had no questions about the experiment. However, they did have questions about the recording procedure, which were asked as they began to write.

Students did not break into pairs or groups for any discussion about the demonstration they had just observed. They simply spent the remainder of the time writing.

There were two laboratory observations this researcher was allowed to make because the other teachers had not planned to teach one when data was being gathered or they were not teaching a required laboratory course. However, in both observations the pattern was the same. These two teachers emphasized verification of known science phenomena. They did not take any time to develop more than mechanical observations and their recording. This suggests that those two incidents may not be isolated, and perhaps represent laboratory practice throughout the country.

Laboratory exercises seem to be another extension of the same methods used to teach science in the classrooms. The difference is, rather than copying chalkboard notes, students spent their time recording observations to confirm science phenomena. There was no emphasis on understanding the relationship of observation and scientific principles. Perhaps another way to view this is that the

laboratory is used as an activity to reinforce content of the Contenidos Básicos de Ciencia.

Another possible explanation is that it is much easier to have a laboratory exercise that confirms known science phenomena as opposed to one that encourages students to raise questions about phenomena or that encourages discourse about students' understanding of them. However, there is another possibility, and that is policy about evaluation established by the Ministerio de Educación Pública.

How science teachers deal with the Contenidos Básicos de Ciencia indicates that interaction between the teacher and students is a very complex phenomenon. However, there are other issues involved, perhaps making this interaction even more complex. For example, there is the issue of just how practical is the design of the national science program for all students. Especially when one considers the existence of student differences based on where they live (urban or rural), the type of school they attend (private or public) and their socioeconomic status.

In the following paragraphs these aforementioned issues will be discussed in greater detail. However, in order to provide the reader with an insight as to the issues involved, Table 2 is provided.

Table 2
Description of Differences Found in Private and Public Schools by Urban or Rural Location

Location of school	Amount of Resources	MEP Support	Students' SES Status	Expectations for Students
Public/ Urban	Very Little	Yes	Very Low to Average.	Low
Public/ Rural	Sparse to None	Very Little	Minimal	Very Low
Private	High	Yes	High	High

As can be seen, public urban and rural science teachers must contend with issues such as the amount of teaching resources available, and students' socioeconomic status. On the other hand, private school teachers do not need to concern themselves with these variables. However, both private and public urban schools do have available to them support from the Ministerio de Educación Pública while rural schools are provided minimal support. In general it seems that greater resources, and higher students' socioeconomic status can possibly lead to higher teachers' expectations. To what extent is not clear. What is striking about the information in Table 2 is that public rural schools have low ratings across each category, and have the highest dropout rate as well.

Differences Found Between Teaching In A Private Or Public School

A chief complaint of public school science teachers was the lack of resources available to them. The following quote is an example of how a public school science teacher who taught a few kilometers from San José, the capital city, is affected.

> One of the obstacles that I have in teaching science is the lack of materials, starting with the idea that one cannot ask public high school student to purchase their own textbook, you can in private schools. There are times when my high school, named "A", has told me to bring my own eraser and chalk because the Ministerio de Educación Pública wouldn't give us any. You cannot make any dittos because there is no paper. There are times that I have to take money from my own pocket in order to have the materials I need (Tico 5).
>
> Uno de los obstáculos que yo tengo al enseñar ciencia es la falta de material, empezando porque a los estudiantes no se les puede pedir libro de texto en un colegio público, en el privado sí se puede. A veces a mi en el colegio de "A" me han dicho que lleve borrador y tiza porque el Ministerio de Educación Pública no da. No se puede tirar (poliografiar) material porque no hay papel. Algunas veces yo saco dinero de mi bolsillo para tener material. (Ibíd.)

As a contrast private school teachers complained of a lack of materials, but they indicated that they could depend on the economic resources of their students to evade this problem.

> In teaching we have economic problems. When we want to organize a field trip to a certain place. (For example), in order that the students can understand how a hydroelectric plant functions, the teacher needs to make all the necessary arrangements, take the extra time and the cost is absorbed by the students and the teacher. The high school only gives permission to go on the field trip. The teacher is not reimbursed for all the extra time (Tico 9).
>
> En la enseñanza tenemos problemas de índole económico. Cuando queremos organizar una excursión a un determinado lugar, para que los muchachos puedan concer como funciona una planta hidroeléctrica, todo tiene que arreglarlo el profesor. Sacar el tiempo extra y los gastos los cubren tanto profesor como estudiantes, el colegio solo da el permiso para que se efectue la excursión. El tiempo extra del profesor no tiene renumeración. (Ibíd.)

There is evidence to suggest that public school teachers do not have the fiscal resources to equip their laboratories and classrooms as well as maintain existing materials. Private school teachers, on the other hand, indicate that they need only to ask for funds from their students for needed expenditures.

From personal observations it was noticed that most public school laboratories were lacking in materials. General laboratory equipment such as scales, balances, test tubes and beakers were noticeably lacking. Classrooms were also barren of any models, charts or other reference materials. In terms of material resources, the opposite was true of private schools. Not only did the classrooms have an abundance of visual aides, but also the laboratories had a large amount of equipment and visual aides.

The exception to these observations was one rural school. It had a well-stocked laboratory filled with items such as specimens, charts, balances. What is interesting about this observation is that a well-equipped laboratory is in contrast to most public school science teachers' complaints about a lack of resources to teach science. This raises the question as to what do teachers mean by resources, because even with a well-equipped laboratory, science teachers in this school persisted in teaching theory, and not providing practical science laboratory exercises.

Emphasis on teaching the science content contained within the Contenidos Básicos de Ciencia could be a reason for not using the laboratory. Though the last year of high school is to be spent in a laboratory exploring biological phenomena, the outline of the Contenidos Básicos de Ciencia, for that year, is all theory. In other words, the processes that develop the products of science are not part of the Contenidos Básicos de Ciencia, thus teachers may take this as a sign that laboratory experiences are not very important.

Another contrast exists between services received, and the availability of resources, which is dependent on the type of school as well as where it is located. A science teacher who was working

full-time in both a public and a private school, and had over 10 years of experience working in rural areas, provides an interesting insight as to differences in the quality of the whole environment of private schools when compared to public institutes.

> First of all in the private school one finds very favorable (teaching) conditions. If one (teachers) does not have something, they need only ask, because the school is obligated to have everything. For example, maps and teaching materials, are provided without a problem. If I need a movie projector, they provide it for me. If I need an overhead projector, even one with a stand, it is also provided. I can use maps that are available and if they are not handy, they (The school) will purchase it for me (Tico 3).
>
> The same applies for students. Everything that I require of them, they will buy it. If I ask (them) to buy a book (teacher trails off and switches into an example). For my 5th year students (senior year of high school), I had them purchase a book that cost between 600 to 800 colones. They purchased it. I do not feel right about it. (Because) I have worked in the other institutions (public schools) where everything has to be given to them. If I ask them to purchase a piece of paper costing two colones, one has to wait forever because they cannot (buy it). (Ibid.)
>
> Therefore, in terms of buying power, (working with) the (private school) student and (in) the (private) school is wonderful. On the other had, one works with nothing (in the rural area), as well as here in San José. Of course there is a great difference between the rural zone (and the urban center) because (in the urban area) everything is available. Here one has a laboratory. But one has to work with what the school has (public school), because you cannot ask the student for anything else. The students cannot buy books, they can hardly purchase notebooks. This is even more true today, in that they economic situation is so bad. One has to make certain allowances (Ibid.)
>
> Primero en la escuela privada se cuentan con todas las condiciones habidas y por haber y si no se tiene se pide porque la institución tiene la obligación de tenerlo todo digamos en cuanto a mapas, material didáctico, se maneja perfectamente, yo necesito un proyector en la escuela y me lo dan, yo necesito un proyector de láminas o de patas y me lo dan, yo necesito un mapa y alli esta, y si no esta me lo compran. Ahora con los alumnos, todo que lo quiero lo consigo también. Si yo pido un libro, yo en quinto año estoy pidiendo un libro que costó 600 u 800 colones y me lo compraron y yo me siento mal porque yo he trabajado en las otras instituciones donde todo que a de ser dado porque si yo pido una hoja de 2 colones hay que esperar porque no pueden.

> Entonces en poder adquistivo tanto el alumno como la institución es una maravilla, en el otro lado trabaja uno sin nada, aquí en San José también, claro que hay un gran diferencia con la zona rural porque aquí estan las cosas, esta el laboratorio, pero hay que trabajar con lo que tiene el colegio porque el alumno no se le puede pedir nada más, los alumnos no pueden comprar libros casi ni cuadernos ahora más que la situación económica esta mala hay que permitirles una seria de cosas. (Ibid.)

This teacher has provided a rich description of private and public schools. The account was based on his experiences working in a private and public school located in San José and public school work in rural areas. He also provided some insight as to some of the reasons why private school teachers, and students, have a greater advantage over their colleagues in public and rural institutions.

Distribution of Educational Resources

Private schools and their teachers work under a different set of guidelines. To begin with, parents and students are much more demanding of the institution. Secondly, the school itself places a great deal of demand on the teachers.

> For example, if I do not go to work one day, I am not paid for that time. If I do not go for two days, I am also not paid for those two days. If I arrive tardy (to work), or let my students go early, and it is noticed by the principal or vice principal, something they watch this very carefully, they reduce my salary (accordingly). Also, there is a great emphasis on providing and maintaining high academic standards. The students demand it. Students and parents demand a good education, and of course the teacher must provide them with one (Tico 3).

> I believe there is no room, in private schools, for a bad teacher because they will soon be gone. We do not have any type of contract. You are history the day that the principal calls and tells us that we are of no use, because of this or that, setting a bad example, or simply of no use as a teacher. Good-bye. (Ibid.)

> Por ejemplo, yo no voy un día al colegio no me pagan ese día y si no voy dos días no me pagan esos dos días y si llego tarde me rebajan y si dejo ir a mis alumnos y la directora o subdirectora se dan cuenta, porque allí si hay buena

> vigilancia me rebajan el sueldo, además como se trata de dar y conservar un nivel académico alto porque el alumno le exige que le den, el alumno y los padres, que le den una buena educación y entonces el profesor le tiene que dar. En los colegios privados yo creo no tienen campo un mal profesor porque ligerito lo quitan, nosotros no tenemos ningún contrato el día que el director nos llame y dice que usted no me sirve por tales y tales cosas, estan dando mal ejemplo o no me sirve como profesor hasta aquí llego usted. Adios. (Ibíd.)

The private school environment seems to exude high expectancies and success. If a teacher needs something they need only ask the school administration or opt for their students to provide it. Students' and parents' expectations are high, and supervision by the administration is geared towards maintaining these same set of high standards. Control is in the hands of the school, teachers, students and parents.

On the other hand, public school teachers, in both the rural and urban areas, work with conditions that are beyond their control. Students are poor, resources and money are scarce and teachers' options seem to be just as limiting. This is frustrating to the teacher.

As an example, a science teacher on the Pacific rural side of Costa Rica reflected on the lack of availability of visual aides.

> In this school there is one movie projector, however it is impossible to use because all of the films are in San José, and here in Puntareans they are not available for our use. In order for us to use films we would need to go to San José, but the school (officials sic) will not give us the permission necessary to miss work. The slide projector cannot be used because none of the classrooms have electrical outlets (Tico 14).

> En el colegio hay un proyector de películas, sin embargo es imposible darlas pues todas las películas estan en San José, y aquí en Puntarenas no disponemos de ellas. Para poder tenerlas tendriamos que trasladarnos a San José y el colegio no da permiso para ausentarse del tabajo. El proyector de diapositivas no se puede usar porque no hay tomacorrientes en las aulas. (Ibíd.)

A lack of laboratory and audiovisual equipment is only one problem. Science teachers also need assistance in improving their practice. The Ministerio de Educación Pública is the agency charged with providing this assistance. When the inservice activities of the Ministerio de Educación Pública include sites other than San José their efforts are sporadic and seem to lack conviction in helping teachers improve their practice. The excuse given by the Ministerio de Educación Pública is a lack of money.

Another Puntarenas teacher provides the following insight.

> We have solicited workshops from the Ministerio de Educación Pública, and they have given them to us, but not on a regular basis. Requests for more workshops are denied by the Ministerio de Educación Pública under the excuse that they do not have enough money for them (Tico 2).
>
> Nosotros hemos solicitado al Ministerio de Educación Pública cursos de actualización, los han dado, pero se interrumpen y pedimos continuidad pero el Ministerio de Educación no cuenta con recursos para proporcionar los cursos. (Ibíd.)

The excuse of a lack of money is real. However it is puzzling that when some science teachers are offered workshops from other sources, the Ministerio de Educación Pública also denies these teachers permission to participate.

> La U.N.A. (Universidad Nacional de Heredia) offered us science workshops, but the Ministerio de Educación Pública did not authorize the request because they are preoccupied with other things (Tico 14).
>
> La U.N.A. ofreció dar cursos de actualización de la ciencia, pero el Ministerio de Educación Pública no los autorizó porque el Ministerio de Educación Pública esta preocupado por otra cosas. (Ibíd.)

It is not clear why the Ministerio de Educación Pública has, in this case, adopted this position. Notwithstanding, a public school teacher from San José indicates that the universities do offer inservice opportunities and they are allowed to attend. Perhaps the

difference is that the Ministerio de Educación Pública frowns on activities of this nature that are conducted during the school day.

> In relation to who facilitates the teaching of science I would have to say that the U (University of Costa Rica) does more than the Ministerio de Educación Pública. For example, the U just finished giving a class in cooperation with CONICIT (National Council of Research in Science and Technology) about how to organize science fairs (Tico 1).
>
> Con relacion a las facilidades para enseñar ciencia, yo diría que hace más la U que el Ministerio de Educación Pública. Por ejemplo la U acaba de impartir un curso junto con el CONICIT (Consejo Nacional Sobre Investigación de Ciencia y Tecnología) sobre organizacion de ferias científicas. (Ibíd.)

But, this person does concur with the notion that the Ministerio de Educación Pública is negligent in offering this type of service.

> The relationship is nonexistent, years pass before we receive any communication from the science advisor or the Ministerio de Educación Pública. Also, one goes to the Ministerio de Educación Pública looking for programs (science) and there aren't any (Tico 1).
>
> La relacion que hay es poca, nosotros pasamos años sin recibir un comunicado de la asesoría o del Ministerio de Educación Pública, directiamente de ciencias. Inclusive uno va al Ministerio de Educación Pública a solicitar programas y no hay. (Ibíd.)

This attitude was expressed by more than one science teacher. With the exception of one private school teacher (Tico 9), who indicated that in 20 years of teaching only once did someone from the Ministerio de Educación Pública come into the classroom, all other teachers confirmed the sentiments of the above quoted teacher.

It seems as if the Ministerio de Educación Pública is willing, in some instances, to provide inservice opportunities for science teachers. What determines whether or not the Ministerio de Educación Pública will give permission is not clear. For instance, in a visit to Costa Rica's Institute of the Improvement of Science Teaching (CIMEC which is funded by the Ministerio de Educación Pública), the staff

indicated providing UNESCO workshops designed to show teachers how to make science equipment for their classrooms. However, these workshops were limited to a small number of participants, offered in San José (the capital city), and took place on weekends or evenings.

The notion of resources can take many forms, one of which is the socioeconomic conditions of students. In this study, the socioeconomic status of students who attended rural or urban public schools was much lower than of their private school counterparts. Students' socioeconomic status served as a source of frustration for most secondary science teachers interviewed, and working in a public school.

A Limón science teacher provides us with the following description of the students in his school.

> We have all categories of students, some from close by but also those from other areas in Limón that have been admitted to another day school. Also there are students with social problems and we even have mentally retarded students who are incorporated with normal students. We also have a type of student called travellers who come from farms and walk sometimes up to two hours to get to school. There are also students from the refugee camps for people from Nicaragua (Tico 17).
>
> Tenemos estudiantes de todas las categorías, muchachos de aquí cerca, pero también estudiantes de otras áreas de Limón que no han podido ingresar al colegio diurno. También hay estudiantes con algún problema sicológico e incusive hay estudiantes con retraso mental con el fin de que se incorporen a los grupos normales. También tenemos los muchachos llamados viajeros que provienen de fincas y caminan hastas dos horas para llegar al colegio. También vienen estudiantes del campamento de refugiados, de gente que viene de Nicaragua. (Ibíd.)

The following is from a public school, inner city, San José science teacher.

> The student population of this school has very little economic resources. I coordinate the Committee for Student Well-being and we try to obtain donations to provide them lunch, invent assignments to arrange trips for them and provide uniforms (all students in Costa Rica wear uniforms to school). But it is only a little bit of help (Tico 18).

> Here we have students who live in cardboard shacks, where there isn't even a toilet. The economic conditions (of the students) in this school is very low. We try to help them. (For example), when there is a student who shows academic potential and is achieving very well, we help him. We even go to his house to bring him to school. (Ibid.)

> Here you cannot administer an examination such as the one the Ministerio de Educación Pública has jut developed. One cannot compare achievement of private school students with that of a state school, especially given the conditions in which we work. Other parameters need to be used in order to analyze our school achievement because a hungry person does not understand. Working in this school would be difficult for anyone. (Ibid.)

> La población estudiantil de 'A' es de muy bajo recursos económicos. Yo coordino el Comité de Bienestar Estudiantial, y tratamos de recaudar dinero para darles almuerzo, se hacen estudios para darles pasajes, uniformes, pero es solo una ayuda. Aquí hay niños que viven en tujurios donde no hay un servicio sanitario. Las condiciones económicas de 'A'son muy bajas. Nosotros tratamos de ayudarles. Cuando hay un alumno que es capaz y tiene buen rendimiento lo ayudamos, inclusive lo vamos a traer a su casa. Aquí no se puede hacer un examen, como el que acaba de hacer el Ministerio de Educación Pública, para comparar el rendimiento de una institución privada al rendimiento de una institución estatal, máxime en las condiciones en que trabajamos aqui. Tendríamos que utilizar otros paramétros para ver el rendimiento, porque una persona con hambre no puede entender. Trabajar en esta institución es difícil para cualquiera. (Ibíd.)

One teacher commented on how the Ministerio de Educación Pública does not take into consideration their lack of resources when they are evaluated.

> In spite of this situation which is so critical, at the national level, at times we are forgotten. This is a much forgotten rural zone, ignored many times by the central sector that has tried to evaluate us as if we have everything (Tico 10).

> No obstante, en vista de la situación tan crítica a nivel nacional, y que a veces estamos olvidados porque esto es una zona rural bastante olvidad de los sectores centrales, que lo que hemos hecho es tratar de juzgarla como lo que tenemos. (Ibíd.)

If differences between rural and urban schools, or social and economic disparity between public and private school students (to be

discussed later) are not accounted for when measuring performance, then results would seem to be misleading.

The needs of these teachers' students does seem to make their job more difficult. An inner city public school teacher captures this feeling in the following question.

> How do you expect me to teach science, when I have students who come to school hungry and lack the energy for active learning? (Tico 6).
>
> ¿Cómo espera que yo puedo enseñar ciencia cuando mis estudiantes llegan a la escuela con hambre y falta de energía necesaria para seguir sus estudios en una manera que es activa? (Ibid.)

The government has taken steps to try to meet the people's needs. However, in helping they also may have exacerbated their situation. The following is an example of how this took place.

A complaint voiced by public school teachers was fiscal resources made available to the school did not meet nutritional and health needs of their students. Another is that some students are not able to attend school because of a lack of transportation. These students became victims of a political promise: i.e., homes for everyone. In order to fulfil this promise, the Costa Rican government diverted funds set aside for transporting and feeding students for the building of houses. A Limón teacher (Limón is one of the high dropout zones) explains how it has impacted his school.

> Until last year there was (financial) help from the government for transportation. But they discontinued the help with transportation and the kitchen because everything is being directed towards the government's housing project (Tico 10).
>
> Hasta el año pasado hubo ayuda de parte del gobierno para el transporte pero quitaron la ayuda de transporte y del comedor, porque todo se esta canalizando al proyecto de vivienda que tiene el gobierno. Algunos estudiantes no pueden pagar el transporte y el colegio busca como ayudarles pues si no dejan el colegio. (Ibid.)

The impact on these students is immediate. Unless the school subsidized (in some cases pays the whole cost), they simply do not attend school. One can argue that families should be provided with the basic necessities like a home. However, even though a home was provided, the economic conditions that prevented these people from purchasing one remains the same. In a country like Costa Rica that places a high value on education, these people have gained a state-owned home, but have lost the vehicle necessary to become state independent. Another point is that eliminating state funds does not affect those students who have the resources to provide for this service on their own.

A scarcity of resources seems to relate to Fuller's (1987) study on science achievement in less developed countries. As noted in Chapter I, Fuller contends that school factors (for example, availability of equipment) was a significant variable in explaining low science achievement and not parents' social class. However, in this case it seems that the economic resources of students could be a variable to consider when one is analyzing science achievement. If this is true, then possibly, parents' social class does play a larger part in influencing science achievement than that indicated by Fuller. If some Costa Rican science teachers must contend with nutrition and housing issues, then perhaps parents' social class is also a schooling factor.

Students' Socioeconomic Status

Interviews revealed that in order for some students to continue pursuing an education they must first overcome the social and economic conditions in which they live. As an example, students who attend

public schools, located in the inner city urban centers, may finish high school but not necessarily go on to a university. On the other hand, urban students attending a private school will finish high school and more than likely attend a university.

> We prepare the student for the U (Universidad de Costa Rica) because we know that 90% of them will attend the U. As a consequence we prepare them by providing (students) a knowledge base that helps make U courses easier (Tico 8).
>
> Nosotros preparamos el muchacho para la U porque sabemos que el 90% va a la U. Entonces se les prepara dándoles una base para que los cursos en la U les sean más fáciles. (Ibíd.)

The above quote is from a private school teacher. The next quote is from an inner city public school teacher.

> Very few of them (students) aspire to enter U.C.R. (Universidad de Costa Rica). The main reason is that the 'U' (Universidad de Costa Rica) has just increased tuition costs. Though there are few who aspire to attend the 'U', this does not mean that they do not want to, it is because they cannot. Even so, the academic program in this high school (is taught) with an eye towards the university. We have tried to make the Ministerio de Educación Pública change its orientation to a more vocational one, in order that the student can relate more to his environment, but we have not been successful (Tico 18).
>
> Son muy pocos los que aspiran a entrar a la U.C.R. Sobre todo porque la U acaba de subir el costo de matrícula. Son muy pocos los que aspiran ir a la 'U', pero no porque no quieran, sino porque no pueden. Aunque el programa Académico del Liceo es con miras a la universidad. Se ha tratado que el Ministerio de Educación Pública cambie la orientacion a un vocacional, para que el estudiante tenga un trabajo más a mano con los recursos de ellos, pero no se ha logrado. (Ibíd.)

The principal from this same high school was also interviewed. He corroborates the science teacher's views. He also provides percentages of students who leave his school and some reasons why.

> Normally the difference in percentage amongst those who do not finish a year and those who do is between 36% and 40%. From this (we have ascertained) that 60% of our students suffer from very serious family problems, destroyed homes (many students lived in cardboard homes), alcoholism, etc.

> These are the reasons that many of them leave (school) (High school principal or school where Tico 18 worked).
>
> Normalmente entre los que no terminan el año y los que se quedan, el porcetaje es de un 36% a un 40%. De aquí salió que un 60% de los estudiantes sufren problemas familiares muy graves, hogares destruídos, alcoholismo etc., y eso explica porque muchos se van. (Ibíd.)

In any given year, at least a third of their students can be expected to drop out. On the other side of the coin, in the private school, students will not only stay in school, but they go on to a university. This again implies that there are social and economic issues which can effectively block some students' ambitions to study at the tertiary level. For these students, finishing high school is not enough because they must overcome certain social and economic barriers. What also seems to be a factor is whether or not a student attends a public or private school.

To some extent these findings seem to coincide with Fuller's (1989) suggestion that per-pupil expenditures, teacher quality, and teaching, as well as school management and structure, influence science achievement in developing countries. This assertion, if correct, may be important to consider when one analyzes the differences in the distribution of economic resources between private and public schools, as well as urban and rural schools. Notwithstanding Fuller's allegations, it does seem that science achievement is also dependent on the socioeconomic resources of students.

Comments from science teachers of Costa Rica indicate that poor students do not have many opportunities to pursue tertiary studies. Specifically, the economic conditions of these students seem to counter educational opportunities afforded them. Only in those cases in which students demonstrated outstanding ability, do teachers seem to make

extra efforts. This is not to dismiss their efforts with the other students. However, it is to underscore the difficulty of the situation.

In some ways it seems as if students who come from low socioeconomic backgrounds are doomed to failure, even before they start school. This may be what Erickson (1986) was referring to when he contended that social sorting of students is based on their socioeconomic status.

This raises the question as to who benefits the most from a push towards the development of science and technology. More than likely it will be that person who goes on to the tertiary level. For this study, those who benefit the most from differences in the distribution of resources among local school sites, and the socioeconomic background of students, are private school students. They also have a greater opportunity to pursue tertiary studies than do most public school students. This lead to the question of how relevant teachers feel the Contenidos Básicos de Ciencia is for their students.

Relevancy of the Contenidos Básicos de Ciencia

In the first two years of Nivel Diversificado, the science teacher teaches a more general, non-discipline specific type of science. During the last three years of this same level, science teaching takes on a much more narrow view by focusing in on biology, chemistry and physics. This teaching dichotomy results from the organization of the Contenidos Básicos de Ciencia (refer to Chapter II for a description of the Contenidos Básicos de Ciencia).

What is interesting about the design of the Contenidos Básicos de Ciencia is that it applies, as equally, to a student who lives in a

rural as well as an urban setting, attending a private or public school or preparing for further studies in an academic or vocational institute.

An implication to be considered is that, in spite of the Contenidos Básicos de Ciencia being designed so that all students receive the same science content, not everyone benefits. A teacher from Limón with 13 years of experience teaching science in this area speaks to how the Contenidos Básicos de Ciencia is not meeting the needs of his students.

> I think that the programs (Contenidos Básicos de Ciencia) were developed without thinking of the needs of the student. For example, we pass on general information (science) to the student, but perhaps this is not what the student in this area needs (Tico 10).
>
> Personally, the national programs do not satisfy me because I started working with the old ones. I taught material specific to botany, zoology, physics and chemistry. Today the program is much like a salad. For certain they want to prepare students to have only a general vision (of science). (Ibid.)
>
> Yo pienso que los programas fueron hechos sin pensar en las necesidades del alumno. Por ejemplo se informa al alumno en forma general, pero tal vez no es eso lo que es estudiante de esta zona necesita. (Ibid.)
>
> A mi los programas nacionales no me satisfacen, porque yo empece a trabajar con los programas antiguos. Yo enseñaba las materias por áreas específicas, botánica, zoología, física, química. Los programas de ahora me parecen como una ensalada, es cierto que quieren dar una visión general, preparar al alumno. (Ibid.)

Limón is a city on the Caribbean coast which is a severely economically depressed area. Its population is predominately Blacks who speak English but are instructed in the majority language, which is Spanish. As the teacher from Limón has suggested, these students' science curriculum needs are very different form those of another area. For example, students in this area would perhaps benefit more from a

science curriculum that engaged them in learning about marine fauna or flora, bananas or cacao. However, this may not be enough because there are other issues surrounding the notion of developing applicable science curriculum.

For example, most rural students leave school at the end of the sixth grade, and only three percent of the total population go on to tertiary studies. Perhaps a factor contributing to school dropout is a curriculum that is not considered applicable by students. The national format of the Contenidos Básicos de Ciencia would not seem to lend itself to promoting equal learning opportunity for the students of Costa Rica. This may be a consequence of what Carnoy and Levin (1985) were addressing when they suggested that plans to increase science and mathematics education opportunities do not include ideas of how students will benefit.

As indicated in Chapter II, there is one exception found in the Contenidos Básicos de Ciencia and it is the last year of high school (undécimo año/eleventh grade). In this year, students who are in an Agropecuario program (agricultural/technical/vocational) study botany, while those who are in a general academic program (Nivel Diversificado), spend the year experimenting in a biological laboratory.

Not all students in Costa Rica finish high school, much less go on to study in a university. Most students only finish the sixth grade, and one-half million students do not even obtain a primary education (Institute of International Education, 1986).

The highest incidence of school dropout is found in the north and south along the borders and the Atlantic and Pacific coasts, where both multinational and national companies are involved in banana and beef

production for exportation. The lowest incidence is found in the capital city of San José (La Nación, 1987).

According to a report by La Nación (1985) (one of the main newspapers), there are two dominant reasons for school desertion reported: economic and academic. Students leave school to work or because what they are studying is not applicable to them. Interestingly, La Nación (1985) also reports that science is listed by students as one of the subjects which presents them with the greatest difficulty and the least applicability.

La Nación (1985) indicates that at the primary level in 1984, 2.6% (9,087) day students, and 35% (1,188) night students (adult education that is designed for students who have dropped-out and returned to school), left school. Secondary day students left at the rate of 10.4% (12,141) and night students at the rate of 33.1% (9,836). Overall, primary and secondary urban students left school at a higher rate than did the same rural students when geographical zones throughout the country were compared. However, in comparing the primary and secondary levels, rural students left school at a higher rate than did urban students.

This information reveals several interesting characteristics about the type of student who will benefit the most from the Contenidos Básicos de Ciencia. In general, if a student has made it to the secondary level, and is living in an urban center, he/she will more than likely finish high school. However, if a student lives in a rural area, it is more than likely he/she will finish primary school and not attend high school or drop out in the early stages. This is in line with Bourdieu's (1977) research which indicates that the higher the

grade level a student obtains, the greater are his/her chances of finishing school.

Differences Between Student Expectations of Private and Public School Teachers

Interviews with private school teachers reveal a different viewpoint from that of public school teachers. Their experiences imply elitism and a different set of standards. It appears, in part, that these differences are generated by how the Ministerio de Educación Pública deals with the classification of schools. Also, there is evidence that indicates that other factors may also be involved.

The following quote is representative of private and public school teachers' experiences about completing the Contenidos Básicos de Ciencia and Ministerio de Educación Pública officials' attitudes toward them.

> The regional supervisor does not exactly to go the classrooms, but supervision does take place in one form or another. With us, no. It has been many years of since a supervisor has come to my class and when he/she came everything was fine. As a result they do not worry about private high schools because they know that at the U (Universidad de Costa Rica) the best students come from certain high schools. Perhaps because of this they do not supervise us very much, but the public high schools do have to finish all of the Contenidos Básicos de Ciencia (Tico 9).
>
> El supervisor regional no llega exactamente a las clases, pero si hay una supervisión en alguna forma. Con nosotros no. Yo tengo años en que al supervisor no llega y cuando llegaba todo estaba bien, entonces allos no se preocupan del colegio privado porque saben que a llegar a la U los mejores estudiantes vienen de ciertos colegios. Tal vez desde ese punto de vista no supervisa mucho, pero en los colegios públicos sí tienen que cumplir los programas. (Ibid.)

If a different set of standards are applied to the public schools then this would imply that students in private schools could be

receiving, in qualitative terms, a different set of experiences than those in public schools.

Carnoy and Levin (1976) have argued that there are qualitative differences in schooling based on socioeconomic levels. For Costa Rica this is an import point to consider because only those who can afford to attend a private school do so. As a consequence, classroom practice could serve to reproduce and maintain differences between students because different skills are emphasized.

Perhaps in Costa Rica private school students are taught with an eye towards developing their future potential as leaders. This is because their teachers recognize that they will more than likely go on to the tertiary level. On the other hand, public school students may receive a much different type of education because to do more may be seen as a futile effort by science teachers.

The underlying issue seems to be that teaching differences between private and public school teachers could be linked to how the Ministerio de Educación Pública views science education. Specifically, the Ministerio de Educación Pública has a very defined objective for the teaching of science: One learns science because this knowledge is viewed as essential to an individual's social and economic development and, by implication, Costa Rica's.

Many of the science teachers interviewed don't agree. Suggesting that though differences may exist in the attitudes and beliefs about science teaching between private and public school teachers, these differences may be a consequence of the design of the educational system or created by an unequal distribution of students' social and economic resources.

It is interesting to note that a lack of in-class supervision by representatives of the Ministerio de Educación Pública does not seems to be a contributing factor. The following quote is representative of public school teachers' experiences with supervision.

> In all of the classes which I have taught a Ministerio de Educación Pública science consultant has never come in (Tico 17).
>
> Sí. En todas las que he enseñado no ha llegado un asesor nunca a mi aula. (Ibíd.)

However, the issue of supervision can be direct or indirect. In this study, for science teachers supervision was found to be indirect and taking place through the school's principal as well as through examination policies. As discussed in Chapter II, the Organo de Ejecución y Supervisión is charged with ensuring that the programs and objectives of the Ministerio de Educación Pública are being carried out. According to the science teachers in this study, they do not fulfill this role via classroom observations, but through the paperwork provided by the teachers to the principals.

> Supposedly the supervisors should come and ensure that we are doing our job but they generalize their responsibilities so much that they do not come. The immediate impact is that this obligation falls onto the principal of the school. We give the principal our plans, teaching methods, laboratory activities, but from the Ministerio de Educación Pública nobody comes. In my 16 years of teaching never has anyone come to my classroom to observe (Tico 3).
>
> Se supone que los supervisores deben venir a controlar tanto al que trabaja, como al que no, porque alli es donde esta lo malo que aquí se generaliza y entonces del todo no vienen. La obligación inmediata del asunto es que a quien la cae la responsabilidad de la supervisión es al director. Nosotros le damos el planamiento, los instrumentos, las guías de laboratorio pero del Ministerio de Educación Pública no viene nadie. No hay un supervisor regional. En 16 años de enseñar jamas ha llegado nadie a la clase. (Ibíd.)

From Limón we are offered the following information.

> Nobody comes to our classes to see if we are teaching the program (Contenidos Básicos de Ciencia), we ourselves are conscious of the need to teach them. In this high school there is one science department and the department head is in charge of seeing that this task is carried out. Even though the program is not a straight jacket we still try to teach the objectives and the content. In 13 years of work not once did the science advisor come and see (what I was doing) (Tico 10).
>
> Nadie llega a las clases para controlar si se esta cumpliendo el programa, nosotros somos conscientes de la necesidad de cumplir. En el colegio hay un departamento de ciencia y el coordinador es el encargado de controlar. Aunque el programa no es una camisa de fuerza tratamos de cumplir con los objetivos y los contenidos. En 13 años de trabajar solo una vez llegó el asesor. (Ibíd.)

If supervision in the classroom is not an issue, what could be some other explanations for teachers staying so close to the Contenidos Básicos de Ciencia?

Some teachers did attempt to make the Contenidos Básicos de Ciencia more relevant for their students. For example, in Limón a teacher did not strictly adhere to the Contenidos Básicos de Ciencia. However, his noncompliance activities were minimal and he considered them to be dangerous.

> I like to get around the Ministry's politics. Specifically I enjoy doing things on my own initiative that are not part of the program because there have been many times that we are teaching something that the students are not interested in. At these times it is best to give them something from here that will help them understand the world they live in. In order to do this I take them on excursions and try to do something, but I do not dare do much (Tico 10).
>
> A mi me gusta trabajar con las políticas del ministerio, o sea me gusta hacer cosas de mi propia iniciativa, como que no calzan dentro del programa, pero yo encuentro eso que muchas veces estamos dando una cosa que a los muchachos no les interesa, a veces es mejor darles algo de aquí que les ayude a comprender la realidad que los rodea, para aliviar esto yo los saco a excursiones y trato de hacer algo pero no me arriesgo mucho. (Ibíd.)

The following quote pertained to the old program when activities were suggested and goals established. Though this teacher talked about

a variety of activities, they were considered to be extracurricular to the Contenidos Básicos de Ciencia.

> One can modify (the Contenidos Básicos de Ciencia) in accordance with one's interests. As a result I plan more activities. Generally speaking there are more activities and they are different than the recommended or required ones. What we are obligated to meet are the objectives and the (science) content. Activities are ideas or advise that one can choose to realize. For example, if you have your activities to realize a certain objective you do them (Tico 8).
>
> Puede uno modificarla de acuerdo a sus intereses y luego planeo mis actividades. Generalmente son más actividades, diferentes de que a los conseja u obliga aquí. No lo que obliga aquí es objetivos y contenidos, las actividades son unas ideas o un consejo que uno puede realizar. Y por ejemplo usted tiene sus actividades para realizar ese objetivo usted haces sus actividades. (Ibíd.)

The following quote from a private school teacher indicates how he circumvents the dictates of the Ministerio de Educación Pública. This was the only teacher who eliminated parts of the Contenidos Básicos de Ciencia. He also reinforces an idea presented earlier, which is that private schools are subjected to different rules than are public ones.

> The national programs are very old, there are four teachers (of science) in this high school and together we adapt the programs according to our needs, because we are a private school we have the right to do so. For example in the ninth year there is a section on simple pulley machines, which at this time does not have any meaning (at the time we are to teach it). I eliminate this chapter on simple machines and replace it with a study of a power plant because we use electricity from there (the local energy plant) (Tico 9).
>
> Los programas nacionales son muy antiguos, en el colegio somos cuatro profesores (de ciencia) entonces hacemos una adaptación muy propia de los programas, como somos un colegio privado tenemos todo el derecho de hacerlo. Por ejemplo en el programa de noveno año hay una parte de maquinas simple de poleas, que eso no tiene sentido en este momento. Yo quito ese capítulo de máquinas simple y pongo la electricidad por planta, porque nosotros utilizamos la electricidad de allí. Los profesores de colegio públicos no tienen esa flexibilidad. (Ibíd.)

Other Examples of How Teachers Do Not Always Comply with Policy

The following are specific examples of activities of how a public, and a private, high school teacher indicated that they did not strictly adhere to the Contenidos Básicos de Ciencia. The public school teacher was interested in trying to develop activities that help students understand science phenomena. The other teacher included activities that related what the science students were studying to the world they live in.

The following account is from the public school teacher.

> First I study what science phenomena is to be learned and I decide what is the most important. Next I determine the approximate amount of time it would take to develop each theme. Based on this I calculate the hours I will need and then I decide how much (science is going to be taught) (Tico 4).
>
> Sometimes, because the (science) programs have been around for many years of, there are people (teachers) who plan once and stay with the same program for many years of. Not me, I plan every year. Specifically because students change. Another issue is that there are times you may have students who were retained. If you teach the same thing, and in the same way, they will be bored. Therefore, what I do is plan and make changes based on last year's experiences. I try to correct what did not work, and build on it in such a way that it (science learning) is better and more agreeable (for the students). (Ibid.)
>
> What I like best are the games. For example, in the seventh grade I enjoy including games and other things that please (the students) more. Oh yes, that they (students) enjoy coming to class. Yes. This is precisely why I do it. So that they feel good. (Ibid.)
>
> I remember one time we were studying the wind. The direction of the wind and all that. We then decided to make kites and fly them in the school's quad. I then instructed the students to fly the kites and observe from where the wind blew and all of those kinds of things. This lasted two lessons (each lesson is a one-hour block of time), and we came back into class and had a discussion. Well, the results were fantastic. Another day we built paper boats and put them in the water to see where they would go. (Ibid.)
>
> Primero lo que yo hago es lo siguiente, veo los contenidos y en esos contenidos yo voy viendo que es lo más importante. Después veo más o menos, cuanto duraría en desarrollar cada

> tema y de acuerdo a eso voy poniendo las hora qu voy usando y después decido cuanto. (Ibíd.)
>
> A veces como los programas duraban varios años, hay gente que planea para un año y sigue todo los años con el mismo programa. Yo no, yo planeo todo los años porque precisamente, porque los estudiantes cambian y después otra cosa que a veces usted tiene alumnos repitentes y si usted vuelve a dar el mismo y en la misma forma, se aburren. Entonces lo que yo hago es planear y lo modifico y de las experencias que he tenido el año anterior trato de corregir lo que no resultó y de ampliar de tal manera qu sea mejor y más agradable. Lo que más me gusta son los juegos, por ejemplo en el caso de séptimo a mí me gusta a incluir juegos y cosas así que les agraden más. (Ibíd.)
>
> Así, que ellos sientan gusto por llegar a la clase, si. Precisamente por eso lo hago porque ellos sientan gusto. Yo me acuerdo una vez que estabamos viendo lo del viento, la direción del viento y todo eso entonces en la clase hicimos papelotes y los fuimos a alzar a la plaza del colegio entonces yo les decía ahora se fijan en los papelotes, vayan y los elevan y fíjense para adonde sopla el viento y todas esas cosas. Duraron como dos lecciones y después llegamos a la clase e hicimos la discusión bueno esto resultó fantástico. Otro día hicimos barquitos de papel y los echamos en el aqua para ver adonde se iban. (Ibíd.)

The private school teacher, upon hearing about the accident at Chernobyl, decided to start a series of discussions exploring the pros and cons of nuclear energy.

> I adapt the program (Contenidos Básicos de Ciencia) as necessary. For example, we are not studying nuclear energy. At the time of the Chernobyl explosion, I stopped, changed and started a round table discussion about nuclear energy (Tico 9).
>
> Adapto los programas a la necesidad. Por ejemplo en este momento energía nuclear se ve por sí mismo. Entonces cuando la explosión Chernobyl, pare, adapte y estamos en discusión en mesa rodonda sobre el problema de energía nuclear. (Ibíd.)

Unfortunately, these and other efforts are not tailored to the mandates surrounding the Contenidos Básicos de Ciencia. Therefore, even though students are probably engaged in practical experiences of a meaningful nature, they may not lend themselves to passing a science test based on the Contenidos Básicos de Ciencia. This would be

especially detrimental when students take the nationalized science examination. Their scores would not necessarily reflect those needed for entry into a university or other type of training. In effect, students and teachers are penalized for trying to enrich their teaching and learning experiences.

CHAPTER VI

FINDINGS AND IMPLICATIONS

Introduction

The purpose of this study was to investigate (a) how educational policies in Costa Rica were formulated and (b) how these policies influenced practice. Two questions were raised, as framed within the stated purpose of the study. First, what role does the Contenidos Básicos de Ciencia play in science classrooms of Costa Rica, in relation to how and what type of science is taught? The second question was in a broader context: What was the Ministerio de Educación Pública's rationale, and what were the mechanisms involved, in designing educational policies and programs in Costa Rica? In short, this was a study of the formulation of governmental policies and their influence on secondary science teachers as they plan for, and carry-out their teaching.

Background For The Study

The background for this study is divided into two parts. The first is this researcher's experiences with science educators from Latin America. Conversations with these colleagues kept pointing to the notion that science teaching was in many ways linked to influences beyond the science teacher's control. The source of these influences, and the types of obstacles they created for the science teacher, became the starting points for further questions which were mentioned in Chapter I. Also, during in-country data collection, a pattern emerged which suggested that the attitudes and beliefs of science teachers,

especially those who worked in rural and public schools, seemed to be affected the most by programs and policies established by the Ministerio de Educación Pública. Thus, the possibility of the existence of influences on science teachers' attitudes and beliefs about science teaching, and their origin, served as another framing idea for this study.

Assumption

The assumption made in this study is that Costa Rican science teachers' attitudes and beliefs about science teaching and learning, and how they teach, are linked to influences that come from within the educational system, such as policies and programs, as well as other types of forces--the leadership elite of Costa Rica, for example--as well as their own experience.

For purposes of this study, the leadership elite of Costa Rica are represented by both the private sector and politically appointed ministers. The private sector leadership elite is composed of those individuals who represent national and multinational industrial and manufacturing concerns. On the other hand, politically-appointed ministers, such as the Ministro de Educación Pública, are the leadership elite representing governmental concerns. It is the role that the private and governmental sectors envision for education--science education in particular--that is assumed to influence the development of policy and programs.

Findings

The findings from this study are divided into three main groups: (1) findings that pertain to the private sector, (2) findings that pertain to the Ministerio de Educación Pública, and (3) findings about

teachers' views and practices. Findings in groups 1 and 2 are under the heading of "Policy Formulation" because both the private and governmental sectors (the latter represented by the Ministro de Educación Pública) are the main forces behind the development of policy. The findings relative to the private and governmental sectors are based on official documents and newspapers. Findings in group 3 are derived from interviews with 18 secondary science teachers and reviews of their lesson plans and examinations, and other pertinent documents, such as school policies.

Policy Formulation

Private Sector

- Believes that education should emphasize the development of basic skills and academic discipline (e.g., better study habits) because they are vital for economic development.

Ministro de Educación Pública

- Education should emphasize the learning of science facts because this will produce a more productive work force, which is needed in order to advance science and technology within the nation.

Programs

- The Contenidos Básicos de Ciencia was restructured in 1987 to emphasize the teaching/learning of science facts.
- The objective of the Contenidos Básicos de Ciencia is to develop a base of scientific facts for students who pursue studies at the tertiary level in science or engineering.

Policy

- All science teachers are required to teach the science facts defined in the Contenidos Básicos de Ciencia for every academic year in secondary school.

- All site administrators are charged with the responsibility of ensuring that science teachers comply with the aforementioned policy.

- Regional supervisors are charged with the responsibility of ensuring that site administrators follow policy pertinent to the Contenidos Básicos de Ciencia.

- A national test is being designed that will be based on the Contenidos Básicos de Ciencia, and will be administered to students at the end of each academic year.

- A rigid set of guidelines that science teachers must abide by when assessing students. These guidelines define what types of questions may be asked, which material may be used as a basis for questions, and students' rights regarding testing. They also provide for the establishment of local school site evaluation committees to which teachers must submit all examinations for prior approval.

- Only 2.4% of students will attend a university.

- 97.6% of students are not well represented by policy that ensures the teaching of the Contenidos Básicos de Ciencia because it is designed for those who will attend a university in order to pursue a science or engineering degree.

- Science teachers only use the laboratory when mandated to do so by the science sequence determined by the Ministerio de Educación Pública--during the last year of high school--thus reinforcing the notion that students should learn science facts rather than develop an understanding of scientific knowledge and how it has been formulated.

- The laboratory is used as another way of confirming known science phenomena, specifically that which is represented in the Contenidos Básicos de Ciencia.

- Most science teachers lack the training necessary to make homemade science materials for the laboratory.

Teachers' Views and Practices

- Both private and public school teachers believe that the Contenidos Básicos de Ciencia does not meet the needs of all students.

- Private school teachers believe they are preparing their students for university study.

- Public school teachers believe they are not.

- Public school teachers feel they do not have enough teaching resources; thus, their job is very difficult.

- Private school teachers also believe they lack resources; however, they indicated that students and the school, if asked, can provide all that is needed.

- Private school teachers feel they work in a demanding environment, which includes high student achievement and high parental expectations.

- Public school teachers feel that they also work in a demanding environment. However, they attribute the difficulty of their situation to the socioeconomic condition of their students and a lack of resources at their schools.

- Rural science teachers feel that the Ministerio de Educación Pública ignores their resource and inservice needs.

- Public school teachers do not feel that the Ministerio de Educación Pública is aware of the discrepancy between the Contenidos Básicos de Ciencia, their students' needs and socioeconomic status.

- Public school teachers allege that the Ministerio de Educación Pública has reduced fiscal resources to a level that forces them to incur many expenses, such as food and clothing for students and teaching materials, out of their own pockets. This belief, and what they perceive as low salaries, are sources of resentment on their part.

- A combination of school factors and students' socioeconomic status contributes to a student's inability to pursue tertiary studies.

- The attitudes and beliefs of science teachers about science teaching and learning are different than that of the leadership elite or the Ministerio de Educación Pública.

- Science teachers feel they should teach the Contenidos Básicos de Ciencia because they are mandated by law to do so.

- Science teachers believe that science teaching and learning should be fun, practical and relevant. No mention was made of economic development by advancing science and technology.

- Science teachers' lesson plans did not reflect their beliefs. Rather, they reflected a need to meet the objectives set forth in the Contenidos Básicos de Ciencia.

- Science teachers recognize their students' unique needs; however, they use the Contenidos Básicos de Ciencia as a basis for most curriculum decisions.

- Science teachers do not strictly conform their teaching to the Contenidos Básicos de Ciencia. However, they considered their behavior to be somewhat risky because it is against policy.

- Science teachers feel a sense of frustration and resentment when dealing with the Contenidos Básicos de Ciencia.

- Science teachers do not have autonomy in decision making regarding the teaching of science.

- Science teachers feel that, because of a lack of student textbooks, they need to use the Contenidos Básicos de Ciencia as a textbook; and this becomes an excuse for didactic teaching.

- Didactic methods of teaching seem to be the norm regardless of the type of school, the background of students or the availability of resources.

- The lack of time in an academic year and the large amount of material they must cover, as prescribed by the Contenidos Básicos, are other reasons they give for teaching didactically.

Conclusions

After analysis was completed, three main themes were found. First, educational policy and programs seem to be a product of issues that derive from economic, political, sociological and technological factors, as well as the views of governmental and private sector leaders about the role that education plays in economic development. Second, educational policy and programs and higher education (content and teacher education studies) appear to influence science teachers' beliefs and attitudes regarding science teaching and learning in many

ways. Third, how science teachers teach seems to be a consequence of these influences.

In Costa Rica, science teachers are influenced by many issues, one of which is meeting educational objectives established by the leadership elite (private sector) and the Ministerio de Educación Pública (governmental sector). The vision shared by private and governmental sectors is to coordinate education with the advancement of science and technology by developing the scientific background of Costa Rican youth. For example, official documents and newspaper stories reveal that governmental and private sector leaders and/or the elite of Costa Rica are concerned that students lack the basic scientific knowledge needed to contribute to Costa Rica's future economic development. In response to this problem, the Ministerio de Educación Pública revised the Contenidos Básicos de Ciencia, in 1987. However, the policymakers do not appear to differentiate between science education needed by 2.4% of the youth who are university bound and 97.6% who hope to enter the work force directly. Further, the policymakers do not appear to recognize the role of science education as preparation for decision making about such matters as personal health, environmental choices and/or consumer choices.

Science teachers of Costa Rica perform their work in a complex, intertwined milieu of influencing factors. Collectively, these forces influence teachers' attitudes and beliefs about science teaching. For example, the underlying objective of the Contenidos Básicos de Ciencia is to graduate students from high school so that they can be successful in pursuing science or engineering careers at the university level. Evidence gathered in this study indicates that science teachers' attitudes and beliefs are not in accord with the objective of the

Contenidos Básicos de Ciencia. Specifically, how science teachers adopt, as well as adapt to, the Contenidos Básicos de Ciencia is the manner in which they cope with this milieu. Thus, governmental policies are a more persuasive force in determining what science teachers teach than most students' needs, which are based on their own socioeconomic realities. This should come as little surprise, because the teachers themselves have been educated as part of the elite during their university study. As a result, the knowledge they possess and value tends to be academic knowledge, and they have only limited ability to apply this knowledge to the daily lives of students who come from a non-academic world.

Another issue that influenced teachers' attitudes and beliefs was the differences between private and poor urban or rural school teachers: A disparity between the resources available to them and attitudinal differences towards students. For example, private schools had a greater amount of teaching resources, and teachers expressed high expectations for their students. On the other hand, poor urban and rural schools had very limited teaching resources, and teachers expressed very low expectations for their students. In these cases, the socioeconomic background of students and the school environment were two other issues that influenced teachers' attitudes and beliefs about science teaching.

Because of attitudinal differences between private and public urban/rural school teachers, the socioeconomic status of a student does influence science achievement. Students who could afford to attend private schools were educated in an atmosphere of high teacher expectations. On the other hand, public or rural science teachers had very low expectations for their students, because of the socioeconomic

status of their students. Specifically, these teachers feel there is little chance of their students going on to university studies.

In spite of the fact that there are material differences between the private and poor urban or rural schools, data indicate that this is not the major problem. It seems as if science teachers lacked methods or experience that would enable them to use, more effectively, resources that were available to them. The source of this problem could be attributed to teachers' university education or because the Ministerio de Educación Pública did not provide adequate inservice opportunities for teachers.

As was discussed in Chapters I and V, research indicated that teachers could be considered as either transmitters or interpretive agents of a curriculum. Analysis of the results of this study did indicate that science teachers viewed their teaching roles as being transmitters, or literal interpreters of the Contenidos Básicos de Ciencia. It should be noted, though, that most teachers did indicate, to varying degrees, deviating from the absolute dictates of the Contenidos Básicos de Ciencia, and Ministerio de Educación Pública policy, thus attempting to make science more applicable to students' needs, or to fit the realities of their classrooms. However, their lesson plans were centered round the idea of completing the Contenidos Básicos de Ciencia; and since they are university educated, with little applied knowledge of science, they showed little inclination toward alternatives.

In summary, science teachers' attitudes and beliefs regarding science teaching were influenced directly by their own educational background, the Contenidos Básicos de Ciencia and educational policy that serves to enforce the Contenidos Básicos de Ciencia. Thus, the

design of the educational system ensures that teachers comply with mandated policies and programs first, and science teaching/learning second. Science teaching was also influenced by national examinations based on the Contenidos Básicos de Ciencia, a rigid system of assessing students, differences based on whether a school was private, poor urban or rural, and a lack of opportunities for continued professional development for teachers provided by the Ministerio de Educación Pública.

Implications

In Costa Rica, the Ministerio de Educación Pública develops the Contenidos Básicos de Ciencia without the input of science teachers. The Contenidos Básicos de Ciencia is the framework that science teachers used when making decisions about teaching science. Perhaps if science teachers have more latitude in the curriculum decision-making process, at both the classroom and national levels, conflicts between science teachers' attitudes and beliefs and practice would be minimized.

For example, there was a conflict between teachers' attitudes and beliefs about why science should be learned and actual practice. The source of this conflict is the policies and programs established by the Ministerio de Educación Pública. The Ministerio de Educación Pública mandates that all science teachers teach the Contenidos Básicos de Ciencia. One objective of the Contenidos Básicos de Ciencia is to prepare students to pursue the study of science and engineering at the tertiary level. A conflict arose when teachers felt frustrated by having to teach what they consider an irrelevant and impractical science curriculum to their students.

This particular conflict was most apparent in the public school teachers, while private school teachers only hinted at it. Public school science teachers were aware that the majority of their students would not attend the university and, as such, their students needed a science experience that was not aimed at facilitating university study. Yet the Contenidos Básicos de Ciencia did not provide for such an experience. Regardless of their students' apparent need for more practical and relevant science experience, they were required to teach science as dictated by the Ministerio de Educación Pública, despite the fact that they knew that it was a fruitless effort to prepare their students for such study. Their teaching efforts were not richly rewarded, and they were frustrated. On the other hand, private school teachers only hinted at this conflict. Even though they may have been at odds with the objectives of the Contenidos Básicos de Ciencia in many respects, because many of their students would be pursuing university studies, their efforts were "rewarded"--there was a practical reason for following the dictates of the Contenidos Básicos de Ciencia as established by the Ministerio de Educación Pública.

It would be relatively easy to point an accusing finger a the educational policy and programs developed by the Ministerio de Educación Pública and let it go at that. However, the conflict between teachers' attitudes and beliefs and practice is a very complex one and is also linked with other factors. These factors include a teacher's own educational and personal experiences and, in the case of private school teachers, high expectations of the school, parents and students.

For example, the university training that science teachers are required to undergo includes an emphasis on academic knowledge and the Contenidos Básicos de Ciencia. Further, these teachers are likely to

be from that strata of Costa Rican society that has the means to send their children to study at a university. The teachers' own social and economic background, as well as their formal education, contribute to the development of a set of attitudes and beliefs that are, in some respects, "elitist." This may give rise to a conflict between their students' learning needs, how they were taught to impart knowledge, and the type of knowledge they are required to provide to their students.

This conflict can become very personal. The reactions of science teachers vary. For example, some teachers may simply point a finger at the Ministerio de Educación Pública. They feel that the situation has been taken out of their hands and that there is nothing they can do. Still others (e.g., private school teachers), because of where they work and who they teach, may never have a conflict about how they feel about teaching science and the relevancy of science for their students. Still other teachers may become so frustrated and feel so powerless, that they choose to leave the profession for one that allows a greater degree of professional control.

The issue of conflict is not limited to Costa Rica and is an important point for science educators in most nations where science curricula are centrally determined. Perhaps simultaneous efforts should be made, through inservice training of teachers, to develop strategies to resolve personal conflicts that teachers may face in the future in teaching science.

In the case of Costa Rica, educational leaders should take note of these conflicts when restructuring policies and programs. Resulting policy and programs would then be (a) based on the realities of those who teach and learn in science classrooms, and (b) science teachers would spend their time conforming to students' needs and to the

policies of the Ministerio de Educación Pública, because of the compatibility between them. This differs from the current situation where the two are incompatible.

The argument is not that a top-down decision model is necessarily inappropriate. The argument is centered around the idea that what is not effective is a top-down model, that results in decisions which are not practical to those who must implement policy on a daily/weekly basis. The implication of this idea is that even though decisions are considered practical for a given situation, they must be based on an understanding of how the educational system can accommodate national goals.

The significance for curriculum developers is that if science curriculum were developed which incorporated the views of science teachers, then these realities would be defined by, and within, the context of the situation. As such, the cultural setting of the science teacher would necessarily be incorporated.

The essence of this idea is that curriculum developers need to understand the capabilities of science teachers in terms of training, the educational system, communities and their students in any science curriculum development project prior to implementation. This would seem to be especially so in a system where curriculum choices are severely limited.

Still another implication of this study is the notion of how to facilitate science teachers' daily work. The Ministerio de Educación Pública should make efforts to (a) provide teachers with the resources necessary to perform their jobs and (b) develop a continuous inservice program that provides various methods and techniques for teaching science. The last suggestion, (b), would serve a dual purpose. First,

it would help science teachers increase their professional ability and, second, it would help them develop the confidence needed to adapt to their classrooms. In other words, teachers would become empowered to teach science. Empowerment would be enhanced further if university teacher education programs reflected the practical matters which influence teachers in their work. For example, the science content knowledge of teachers needs to include information about how scientific knowledge is formulated by researchers and how it is applied in the real world by engineers, farmers, health care workers and the many others who use scientific knowledge to improve human existence. This knowledge is virtually lacking in most academic science programs in universities.

Further Research

There are several questions raised in this researcher's mind as a result of this study. These questions fall under two different, but interdependent, areas.

Policy and Programs

1. How can national educational policy and programs be developed that promotes both a nation's and students' economic potential?

2. How can a common vision about the purpose of science education be developed between national leaders, science teachers' training institutes and science teachers?

3. If a common vision were developed, what changes would need to take place in science teacher training programs, and what type of technical assistance should be provided for inservice for science teachers?

4. Leaders in many nations seem to favor the development of a national science curriculum. How would the science achievement of the indigent, of minorities, and of females be affected?

5. Why is it that students who come from the low end of the socioeconomic spectrum typically have the poorest performance in science?

Practice

1. What are the contextual obstacles that science teachers must contend with, and how can teachers be helped to overcome them in order to teach science?

2. What are the specific ways that science teachers circumvent policy and programs, and what are the reasons that underlie this deviation?

3. Do science teachers have the professional knowledge and the time necessary to make critical curricular decisions about which science concepts should be taught?

4. How can science teachers be assisted in meeting the learning needs of the indigent, minorities, and females?

It is hoped that this study will serve as an important first step in examining the relationship between national education policy and its affect on how science teachers practice their profession. An additional step would be to observe, in detail, classroom practice.

Ultimately, the goal of science educators is to understand, in a holistic sense, how teaching and learning of science takes place in a classroom, taking into account all relevant factors and influencing

forces. Only by doing this can we assure that students and teachers work together to construct science knowledge, and thereby engage in a true learning experience.

Intellectual Autobiography

Gathering data in the Spanish language, being subjective when interpreting data and naiveté about the organization of Costa Rica's education system, including science programs, were difficult issues that this researcher had to contend with. It is hoped that providing readers with a description of each of these problems and their resolutions will aid them in their research efforts in a foreign country in which English is not the primary language.

With the exception of one interviewee who received his Ph.D. in the United States, none of the interviewee-participants in this study are English-speaking, that is, they did not speak English with the degree of fluency necessary to clearly express themselves. This was a considerable obstacle because (a) their conversations in their native tongue included many folk sayings and colloquialisms and (b) their body language and hand gestures were indicators of the intensity of their feelings about a particular issue. As a result, when the interview data were translated from Spanish to English and interpreted in the dissertation, problems arose.

Whenever folk sayings and colloquialisms were used by an interviewee, and the Spanish text was translated, an explanation of the intent of the speaker was provided for the reader and was offset in parentheses so that the English text would not be mistaken for a literal translation.

Body language and hand gestures were taken into account by immediately reviewing a tape after an interview and making appropriate notes. I found this to be a very important exercise because clues were provided by the interviewees through their body language and gestures. However, in the future, rather than relying on memory and waiting until the conclusion of an interview to record this type of information, I would suggest that a researcher make the proper notations during the interview itself. This will help reinforce the accuracy of one's raw data.

When this research effort was first started, there was more naiveté on my part about the educational system and science programs in Costa Rica than I realized. This experience has led me to believe that it is important for a researcher to become very knowledgeable about the structure of an organization and its systems and programs before entering the scene. This is because this prior knowledge becomes another source for questions to be asked of interviewees. Follow-up questions could then be directed more towards an interviewee's understanding and reactions.

One of the greatest surprises in this study was the complexity of the milieu within which the science teachers of Costa Rica work. The Ministerio de Educación Pública, the politics of local school committees and the needs of their students are, in their own right, major subjects for study. This realization has led me to think that perhaps science teaching throughout the world is also as complex. It seems to me that, in order to unearth this complexity, an organization should be studied from three different perspectives. The first is an overall understanding and interpretation of the relevant organization. Secondly, one needs to focus on, and understand and interpret, the

larger components of the whole organization being studied. In this case, an example of a "larger component" is the Ministerio de Educación Pública. The third perspective then becomes the teacher in the classroom, and observing and interpreting how he/she teaches. By studying all of these three components, a researcher can then get a clear picture of what the relationships are between them. Thus, the effects of certain rules or behaviors could be traced back to some of their causes.

APPENDIX

APPENDIX A

TABLE 3: DETAILED DESCRIPTIONS OF SCIENCE TEACHERS

Table 3
Detailed Descriptions of Science Teachers

Tico One:	1.	Majored in general science.
	2.	Experience teaching in urban and rural areas.
	3.	Seven years of science teaching experience.
	4.	Non-permanent.
	5.	Public school.
Tico Two:	1.	Majored in general and environmental science.
	2.	Experience teaching only in a rural area.
	3.	12 years of teaching experience.
	4.	Permanent.
	5.	Public school.
Tico Three:	1.	Majored in biology and general science.
	2.	Experience teaching in urban, inner city and rural areas.
	3.	16 years of teaching experience.
	4.	Permanent and non-permanent.
	5.	Private and public school.
Tico Four:	1.	Majored in general science and biology.
	2.	Experience teaching in urban and inner city areas.
	3.	13 years of teaching experience.
	4.	Permanent (on maternity leave).
	5.	Public school.
Tico Five:	1.	Majored in biology, chemistry and general science.
	2.	Experience teaching in urban and rural areas.
	3.	20 years of teaching experience.
	4.	Permanent (on medical leave).
	5.	Public school.
Tico Six:	1.	Majored in general science and biology.
	2.	Experience teaching in rural and urban areas.
	3.	4 years of teaching experience.
	4.	Non-permanent.
	5.	Public School.
Tico Seven:	1.	Majored in general science.
	2.	Experience in teaching in an urban area.
	3.	20 years of teaching experience.
	4.	Permanent.
	5.	Public school.
Tico Eight:	1.	Majored in biology (pre-med).
	2.	Experience teaching in an urban area.
	3.	23 years of teaching experience.
	4.	Non-permanent.
	5.	Private school.

Table 3 (cont'd.)

Tico Nine:	1.	Majored in biology.
	2.	Experience teaching in an urban area.
	3.	20 years of teaching experience.
	4.	Non-permanent (is now a pharmacist).
	5.	Private school.
Tico Ten:	1.	Majored in biology.
	2.	Experience teaching in a rural area.
	3.	13 years of teaching experience.
	4.	Permanent.
	5.	Public school.
Tico Eleven:	1.	Majored in biology.
	2.	Experience teaching in an urban area.
	3.	14 years of teaching experience.
	4.	Non-permanent.
	5.	Private school.
Tico Twelve:	1.	Majored in general science and biology.
	2.	Experience teaching in an urban area.
	3.	5 years of teaching experience.
	4.	Permanent.
	5.	Public school.
Tico Thirteen:	1.	Majored in general science and biology.
	2.	Experience teaching in an urban area.
	3.	8 years of teaching experience.
	4.	Permanent.
	5.	Public school.
Tico Fourteen:	1.	Majored in physics.
	2.	Experience teaching in urban and rural areas.
	3.	18 years of teaching experience.
	4.	Permanent.
	5.	Public school.
Tico Fifteen:	1.	Majored in chemistry.
	2.	Experience teaching in urban and rural areas.
	3.	13 years of teaching experience.
	4.	Permanent.
	5.	Public school.
Tico Sixteen:	1.	Majored in general science.
	2.	Experience teaching in urban and rural areas.
	3.	9 years of teaching experience.
	4.	Non-permanent.
	5.	Public school.

Table 3 (cont'd.)

Tico : Seventeen	1.	Majored in biology.
	2.	Experience teaching in a rural area.
	3.	20 years of teaching experience.
	4.	Permanent.
	5.	Public school.
Tico Eighteen:	1.	Majored in chemistry.
	2.	Experience teaching in an urban area.
	3.	20 years of teaching experience.
	4.	Permanent.
	5.	Public school.

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