Chapter 1

International Perspectives on Science Teacher Education

An Introduction

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Science education has seen its share of reform efforts come and go. For the most part, these reforms have centered around changes in science curriculum and instruction. We are now in the midst of yet another wave of reform, this one sparked by the publication of science standards in several countries. This time, however, the reform efforts are attending to a feature of reform that has often been forgotten: science teacher education. Reformers have realized that new curriculum or innovative instructional techniques need teachers to carry them out. Thus focusing on reform in science teacher education will be crucial to the success of other science education reforms.

The authors of the pieces in this volume have witnessed their share of reform efforts in their countries, some driven by government policies, some by institutional initiatives, and others by the researchers themselves. Collectively the writers paint a promising picture of science education internationally. Their picture is one of change and progress, of commitment and hope. Their stories are presented in the spirit of capturing history and moving forward to inform the future.

OVERVIEW

The opening section of this volume, "Policy and Practice in International Science Teacher Education," takes us to four different nations to examine the development of teacher education and the directions for the future. Appleton, Ginns, and Watters discuss elementary science teacher education

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in Australia, which has moved from a one year program to a four or five year qualification. Borghi, De Ambrosis, and Mascheretti illustrate the reform in science teacher education in Italy with the case of physics teacher education. They challenge teacher preparation programs to provide a wide range of coursework in education, science, and the history and nature of science to engage students in the most current views of best practice. BouJaoude details science teacher education in a variety of higher education institutions in Lebanon and provides a set of recommendations for the future based on the strengths and weaknesses of these programs. Iqbal and Mahmood summarize the science teacher education situation in Pakistan, providing recommendations for higher education to work with teacher inservice agencies to educate future science teachers. The issues that these authors discuss, although specific to their own national contexts, are by no means unique. Their solutions have the promise of informing other nations in the midst of science teacher education reform.

The next section, "Making Sense of Science Teacher Learning," highlights research on student learning in teacher preparation programs. Weinberger and Zohar discuss the use of a curriculum designed to improve higher order thinking skills in a junior high teacher preparation program in Israel. Their study demonstrates that preservice teachers can learn how to develop higher order thinking in their students as a result of developing their own thinking skills. Baird, Brodie, Bevins, and Christol examine the student teaching experience of secondary science teachers in the United States and the United Kingdom. Their work has led to the creation of a model for the student teaching experience. Abell and Jacks tell the story of one student, early in her elementary teacher education program, and how she learned to think like a teacher while participating in a Study Abroad internship in Honduras. These authors are generating knowledge about science teacher education that can inform reform efforts globally.

The final section, "Cross-cultural Perspectives on Science Teacher Education," reports on several international partnerships that are generating new knowledge about science teacher education. Koch and Calabrese Barton tell the stories of Egyptian teachers engaged in a US teacher enhancement project. Their stories help us understand the cross-cultural issues that come into play when instructors and administrators work with teachers from different countries. Pedersen, Bonsttetter, Rioseco, Briceno-Valero, O'Callaghan, and Garcia discuss the political and cultural climate for change in Chile, Bolivia, and Venezuela, and how partnerships with higher education institutions in the US have contributed to science teacher education reform in these countries. The book ends with a chapter by Tippins, Nichols, and Bryan, in which they present the voices of their international colleagues—Amadou, Chun, Ikeda, McKinley, Parker, and

Herrera-- in an attempt to understand scientific literacy and science teacher education from a global perspective.

THEMES

What I have learned from these stories is that the problems faced in science education in a given country, although unique to its history, politics, and culture, also share commonalties with other places. Furthermore, the solutions to these problems, both envisioned and enacted, reveal common themes in our science teacher education work. I would like to explore some of these themes briefly, before setting you off on your own journey through these stories.

Not surprisingly, no place has "arrived" at the pinnacle of science education. The authors, whether from developed or developing countries, describe situations where science education and science teacher preparation are less than adequate for the science literacy goals embraced by governments, citizens, and educators. In many countries, a portion of school-aged children receive little or no science education—because they do not attend schools; because the schools they do attend are lacking in resources, including prepared teachers; or because their language and cultural background exclude them from school science. In many places worldwide, science educators and government officials have recognized the weaknesses in their systems and are making strides to ameliorate the problems.

One science education reform strategy that is clearly at the top of the list, again in both developed and developing countries, is to restructure science teacher education. The authors in this volume agree that it takes time to learn to be a teacher. They agree that teachers must understand science concepts, principles, and the nature of science; how students learn; and science curriculum, instruction, and assessment. They agree that teachers need time in the field, working with students and reflecting on practice. They recognize that teachers are the key to reform and that improved teacher education is an essential feature of successful reform. The other day I heard a radio commentator suggest that, to improve schools in the US, we should close all faculties of education, stop preparing teachers per se, and ask students with bachelor's degrees in any field to teach our children. As a teacher educator, I was appalled by the simplemindedness of this proposal and angered by the lack of understanding of teacher education and the profession of teaching. Many of the initiatives described in this book have the potential to make a real difference in science education around the world.

I challenge all of us who care about schools to create and enact policies and practices aimed at challenging business as usual and changing the status quo.

We should not expect these changes to take place quickly. The success of the reforms will depend not only on the quality of the education program offered, but also on the political, economic, and cultural climates in which they take place. The American Association for the Advancement of Science (1993) was farsighted to recognize that deep and lasting change takes time, and that the year 2061 is a realistic timeline to achieve the science education reforms initiated in the latter part of the 20th century in the US. In other places, however, reform measures may last only as long as the current political regime. What this means for science teacher educators is that we must be forever vigilant, looking for the best opportunities to take action and have an effect. And although we must think globally about the issues and values in science education, we must act locally to affect our particular contexts.

This book is an attempt to highlight some themes in science education reform and describe various efforts to improve science teacher education around the globe. I advise the reader to search for your own connections to the policies, practices, investigations, and stories presented here, and then use them to take action on your own situation. We can understand our own situations better by understanding the situations of others. Collectively we can then continue to change the global landscape of science teacher education.

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Chapter 2

The Development of Preservice Elementary Science Teacher Education in Australia

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Abstract: This paper describes the emergence of the contemporary structure of preservice primary and elementary science education in Australia. We present an historical account of the development of current programs and an analysis that reveals the major trends and influences that have molded the current situation. Major changes have occurred since the late 1970s but the last decade has seen revolutionary restructuring. We discuss the relevant literature, drawing on research reports, reports of national and state governments and other reviews. We analyze how these trends and influences have shaped education policy and preservice programs in universities. We explore as well, emerging trends and implications for future developments.

Teacher preparation in primary and elementary science in Australia has undergone a major transformation over the last thirty years, particularly during the last decade. Like all education, teacher education is influenced by political processes, both within the profession and within the community. In this chapter, we trace the changes that have occurred, the political and educational contexts that have framed these changes, and the effects they may have had on the teaching of science. Most notable has been the increasing intrusion of community politics into teacher preparation, moving it from an activity largely controlled by the teaching profession to the political arena.

The chapter assumes the form of an historical narrative, recounting key events both internal and external to the profession which have shaped elementary science teacher preparation, and a critical analysis of the changes that have resulted. The narrative is told from the perspective of the authors, who have been involved in the field over the period discussed. Since our main area of interest lies in the preparation of teachers for primary and elementary teaching, we have concentrated our story on this aspect of

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science teacher preparation. Our story may also be colored by the fact that we live in the state of Queensland, so our account may not reflect fully events in other Australian states and territories.

THE CONTEMPORARY SITUATION

Currently, preservice elementary teacher education in Australia is undertaken mostly in Faculties of Education in the majority of the 39 universities. While there are some subtle differences in the broad structure of programs, the commonalties outweigh the differences. Most teachers in early childhood settings and elementary schools are accredited through a four year Bachelor of Education degree program. Alternatives for students who have completed a bachelor's degree in a discipline and subsequently decide to follow a teaching career include a one year Graduate Diploma of Teaching, a graduate two year bachelor's program, or a two year master's program. Therefore, the majority of commencing teachers will have undertaken at least four years of university study, often wholly within a Faculty of Education. By comparison the standard entry into the profession in 1960 was completion of a one year certificate of teaching awarded by a teachers college.

Before we explore the background to the development of teacher education fully, we provide for the reader a brief overview of the demographic and political contexts of education in Australia up to and including this point in time.

The Demographic and Political Context

Australia is an island continent with over 18 million inhabitants. Although Australia occupies a large area, much is desert to semidesert, resulting in concentrations of population around the more fertile southeast, along the east coast, and in the southwest corner of the continent. The remainder is sparsely populated. Predominant industries are agriculture, mining, and tourism.

The system of government in Australia evolved from the establishment of colonies in different geographic locations. The first was in Sydney in 1788, and over the ensuing decades other colonies began either as British penal settlements, or as centers for settlers who spread rapidly in search of new lands. The main settlements eventually became centers of government for separate states: New South Wales, Victoria, Tasmania, South Australia, Western Australia, and Queensland. Each state provided basic services such as public education, though churches had originally assumed the sole

responsibility for this. In 1901, the Commonwealth of Australia was established as a federation of states. The power and influence of the federal government have increased progressively in terms of its influence on national policy, particularly through taxation and distribution of revenue.

Education in Australia

The provision of free compulsory education was an early initiative of the colonies and continues to be the responsibility of each state and territory (a territory is an area not originally party to the formation of the Commonwealth but separate from the states). Currently, the Commonwealth government provides supplemental funds to the states and territories for the elementary and secondary sectors, and assumes funding responsibility for the tertiary sector. Free tertiary education was introduced in 1974 but partial tuition fees were reintroduced in 1989.

Elementary education, or primary school as it is called in Australia, covers Years 1 to 6 (ages 5 to 11) in most states and territories, and Years 1 to 7 in two others, including Queensland. Compulsory schooling extends to 15 years of age, usually to the end of Year 10, with upper secondary covering Years 11 and 12. On completion of high school students may achieve some form of tertiary entrance score which Universities use to determine entrance eligibility. Primary education, or early childhood education (ages 3 to 8) as it is called in Australia, also varies from state to state. Child care and kindergarten are often available for children under 4 years of age, and most states and territories have preschool available for children from 4 years of age.

Administration and the providing of resources for primary and elementary education is influenced by differences in population distribution, political ideology, and physical distance so there is considerable variation in educational structure and curriculum among the states and territories. However, within each state, curriculum development is a responsibility of a central body and while individual schools have some flexibility, programs and structures are relatively uniform.

Our historical account of developments in elementary science teacher preparation in Australia follows.

THE SITUATION PRIOR TO THE 1980s

Approximately thirty years ago the main political processes influencing science teacher preparation in Australia were those emanating from within

the profession, such as teachers, teacher educators, and the elementary science curriculum itself.

Elementary Science Education

Before the 1960s, the only science component of the elementary school curriculum was nature study. About this time, each state began to introduce a more general science syllabus. However, these programs were not well resourced, teachers were not aware of how to teach science, and as a relative newcomer to the curriculum, science teaching received a low priority. The states had their own science syllabuses with consequential differences in emphasis. Elementary science syllabuses produced during the period 1960 to 1990 tended to be based on curriculum development ideas from other countries (e.g., SAPA, SCIS, ESS from the US and Science 5/13 from the UK), and often did not take account of contemporary Australian developments and research findings. In the 1970s, concerns began to be expressed about the quality of elementary science teaching (Symington, 1974; Varley, 1975).

Elementary Teacher Preparation

Forty years ago, the main route to being an elementary teacher in Australia was to receive several years of apprenticeship under the supervision of an experienced teacher after completing Year 10. However, as demand for more and better trained teachers increased, governments began to introduce scholarships as an incentive to boost enrollments. Training was conducted in teachers colleges, where the typical program was one year in length following completion of Year 12. This later increased to two years in the 1960s, and scholarship holders were bonded to work in government schools for several years after graduation. An effect of scholarships being available was to increase the number of men entering the profession to 40 or 50 percent.

In 1971, as a result of a review of higher education (Martin, 1964), the Commonwealth government negotiated a financial arrangement with the states to fund tertiary education. A binary tertiary system was established, consisting of the established universities, and a new group of professional colleges called Colleges of Advanced Education (CAEs). The teachers colleges and industry-training colleges, such as Institutes of Technology, were transformed into the new CAEs, and were encouraged to broaden their program offerings into other professions and fields of study such as business. At this time, elementary teacher preparation became a 3-year diploma program following Year 12. Inservice upgrading qualifications also became

available for practicing teachers to obtain a diploma or degree. Some CAEs offered a preservice 4-year degree, but this was the exception. Programs in CAEs were nationally accredited through state committees, which maintained monitoring and advisory roles. Other state committees had a role in registering teachers in those states where teacher registration legislation was introduced. Teachers were well represented on the accrediting and registering bodies and most education staff at CAEs were drawn from the teaching force, so the shape and overall content of teacher education programs were largely in the control of the teaching profession. Thus teacher education at that time was firmly embedded in local issues and modeled on apprenticeship training.

Research in Elementary Science

There was little interest in research into elementary science education or elementary science teacher education until academic staff specializing in elementary science were appointed to CAEs. However, the amount of research conducted was limited, since CAE staff were expected to be engaged in teaching and were not encouraged or funded to undertake research. Research was therefore seen as the prerogative of the universities, though none were then engaged in elementary teacher preparation. Despite this, a small number of CAE staff regularly attended annual meetings of the Australian Science Education Research Association[1] (ASERA), which became an important professional link for them, and as such was to later exert considerable influence on elementary science teacher preparation. Several research reports by these people focused on elementary teachers' practices in science teaching (e.g., Appleton, 1977; Henry, 1977; Skamp & Power, 1981; Symington, 1974; Varley, 1975), painting a fairly dismal picture of large scale avoidance of science teaching, and teaching dominated by teacher lectures, television, and whole class discussion.

THE SITUATION IN THE 1980s

Since 1980, a number of related influences have had considerable impact on elementary science teacher preparation. In many cases these influences can be associated with specific events.

[1] The Australian Science Education Research Association (ASERA) was formed in 1970, and renamed the Australasian Science Education Research Association in 1990.

Chapter 3

Reform in Science Teacher Education in Italy

The Case of Physics

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Abstract: In this chapter, we present the problem of the initial preparation of science teachers in Italy. We describe prospective changes both for the preparation of primary school and secondary school teachers and compare with the present situation. We draw attention, in particular, to the preparation of physics teachers as an example of science teacher preparation. Here we report the complete path of their studies (undergraduate and graduate) and discuss the main features that graduate courses should have to prepare effectively preservice teachers for their future work.

At the present time, education in science is accepted as crucial for the cultural development of individuals. The improvement of science teacher preparation is a common aim in different countries. Consistent efforts in this direction are making progress in Italy: changes in teacher preparation have been established by law and a reform of the whole school system is now under discussion. This chapter aims at presenting these changes.

In order to provide a frame, a brief presentation of the Italian school system is initially given. Next the current teacher education system is described. Third we present innovations in teacher preparation for primary and secondary school, focusing on the main features of the new undergraduate and graduate courses respectively for primary school teachers and high school teachers. The case of physics is considered in detail, by drawing attention to the fundamental criteria on which the organization of courses and methodological choices are grounded. We also show how considerations about physics teacher preparation can be extended to other scientific disciplines.

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THE PRESENT ITALIAN SCHOOL SYSTEM

Children enter compulsory school at six years (generally after three years of preschool), and complete it after five years of primary school and three years of junior secondary school. (A law that deeply modifies the organization of our school system, establishing compulsory schooling from 5 to 15 years of age, is now under discussion and it is expected to be approved in the near future).

Compulsory schooling (see Table 1) is the same for all children, including those with mental or physical disabilities for whom specialized support is provided.

Table 1. The Present Italian School System

School	Duration (Years)	Starting Age (Years)
Preschool	3	3
Primary school*	5	6
Junior secondary school*	3	11
High school	5	14
University	4 (5-6)	19

* indicates compulsory schooling

According to the national syllabus introduced in 1985, science should be taught from the very beginning of primary school without a separation of scientific disciplines. Presently teaching activity is shared by three teachers, one of whom has the responsibility for science and mathematics education. In junior secondary school (which is compulsory and lasts three years), the number of teachers increases to eight, but mathematics and science are still taught by the same teacher.

High school (non-compulsory) lasts five years and consists of different sections: Liceo Scientifico (oriented to science and mathematics), Liceo Classico (oriented to the humanities), Liceo Artistico (oriented to the fine arts), and a number of Technical Institutes (Commercial, Industrial, Agricultural, Construction, etc.). As in compulsory school, the syllabus is established at the national level. Scientific disciplines are taught by specialist teachers. In particular, mathematics and physics can be taught by the same teacher; biology, chemistry and health science are taught by another teacher. At the end of high school, students have to pass an examination designed by a national committee for each section of high school. After this examination, students may start state university without passing an entrance examination. (For a few disciplines the enrollment is limited and a selection of students is made by means of tests. The total number of Italian state universities is 64; the number of private universities is quite low). The preparation of students

who enter the university is generally based more on humanities than on scientific subjects; a high frequency of drop-out is common, especially for undergraduate students in scientific disciplines.

PREPARATION OF TEACHERS

In order to show how deeply the preparation of teachers will change in the near future, the present teacher education system is briefly illustrated. Since the preparation of teachers strongly depends on the school teaching level, the case of primary school teachers is described separately from that of secondary school teachers.

The Present Situation

Primary School Teachers

According to a long tradition, primary school teachers are prepared in a special section of high school (Istituto Magistrale). They do not earn a university degree and they usually receive a preparation oriented to methodology rather than to disciplines, especially in science (Borghi, De Ambrosis, and Massara, 1991). The seriousness of their limited education in science was emphasized when the new national curriculum for Italian primary school was introduced. It required that science education be an essential part of primary school from the very beginning and, in accordance with research findings, the science curriculum be experience-oriented (for example, see Bazzini et al., 1985; Bonera, Borghi, De Ambrosis, and Massara, 1983; Bonera, Castellani Bisi, Borghi, De Ambrosis, and Massara, 1981; Goldberg & Boulanger, 1981; Karplus & Their, 1970; McDermott, 1976, 1990a).

A consistent effort to enhance primary teachers' background in science and to equip them with the tools necessary to improve their skills in science teaching has been carried out by the Italian Ministry of Education by launching a national plan of professional development for inservice elementary school teachers lasting five years. About 300,000 primary school teachers were engaged in compulsory courses (aimed at preparing teachers to implement the new curriculum in the classroom) in the following areas: art, languages, history and geography, mathematics, music, and science. The implementation of the national plan of training allowed the research groups in science education in a few Italian universities to test the effectiveness of their research on teacher preparation in proposing new models of inservice education (Borghi, De Ambrosis, and Massara, 1993). In particular, our

experience in a number of courses confirmed that, inside the field of science education for teachers, physics can play a fundamental role, because it allows a complete path from the experiential phase to the formal one. This is to say that teachers must have a good knowledge of fundamental concepts of physics, and have direct experience of what a physics experiment is. We considered it necessary to help primary school teachers acquire significant experience in working with equipment, in recognizing the essential variables in an experiment, in testing models, etc.

The work carried out with inservice teachers suggested guidelines for designing the new project for initial university preparation of primary school teachers which we describe later in this chapter.

Secondary School Teachers

Teachers of scientific disciplines are prepared at the university where they earn one of the traditional science degrees: Biology, Chemistry, Geology, Mathematics, or Physics. For most disciplines, teaching-oriented courses are not offered and, even when such courses are available (as is the case of physics in a limited number of universities) they are not compulsory. In order to be admitted to high school teaching in public schools, besides having a degree in the discipline, passing a national qualifying examination is required. Teaching positions are conferred through a national competitive examination.

The instruction in the subject matter provided by university courses is sound but specialized in each discipline. It fits with the separation of scientific areas in high school, but it is generally too narrow to cover the range of scientific disciplines in junior high school. In any case, teaching as an activity of mediation between discipline and knowledge building of students is usually disregarded. Practicing teachers usually try to fill this lack by attending professional development courses, often funded by the Ministry of Education and organized by different public institutions such as: their schools, teacher associations, Regional Institutes of Educational Research (IRRSAE) and the Ministry. These courses are not compulsory and do not have common features. Based on our experience, teachers appreciate courses grounded in laboratory activity that give them the opportunity to develop and test experiments to include in their teaching practice.

A national plan, National Plan for Computer Science, for inservice teacher education was organized, starting in 1985, with the aim of introducing the use of computers to improve learning in different disciplines, in particular in mathematics and physics. These courses have given inservice teachers the opportunity of participating in the debate on the use of new technologies in science teaching (Arons, 1984, 1990; Bacon, 1992; Hewson,

1985; Hicks & Laue, 1989; McDermott, 1990b; Schwartz, 1989; Taylor, 1987, 1988).

Universities also provide specialized courses on different subjects. The involvement of university researchers in science education in a number of courses allows teachers to gain awareness of the existing research on teaching and learning while providing researchers with new insights on teachers' needs and problems.

The Prospective Situation

A recent law assigns the universities a fundamental role in the education of teachers at every school level. It establishes major changes in initial teacher preparation both for primary and secondary school.

Primary School Teachers

According to the new law, starting from the academic year 1998-99, people who want to become primary-school or preschool teachers, must earn a university degree (4-year) by following a specific curriculum, including courses in content and professional education. The law establishes general criteria and guidelines for the preparation of teachers and gives universities the complete responsibility for organizing the courses. In particular, teachers are expected to attend courses for eight 6-month periods (2,000-2,400 hours total). The percentages of time devoted respectively to disciplinary, general education, laboratory, and teaching practice, must be at least 35%, 20%, 10%, 20%. Professional courses cover 5% and the remaining time can be devoted to elective courses. In the first two years, courses are common to preschool and primary preservice teachers.

As an example, in Table 2 we report the proposal of a committee of the Ministry of Education (MPI) and the Ministry of University and Scientific and Technological Research (MURST). The total number of semester courses to be attended in four years is 50, including eight courses for teaching practice and six elective courses.

As Table 2 shows, 17 courses are devoted to content matter in different areas and are accompanied by teaching practice. A preservice teacher is expected to delve into two of these areas, with not more than one selected from arts, music, and physical education.

A thesis is required and its discussion is part of the final examination. Courses and thesis work aim at developing competence both in subject matter and in cognitive and methodological aspects of teaching. They offer the possibility of building a bridge between psycho-pedagogist and subject

Chapter 4

Science Teacher Preparation in Lebanon

Reality and Future Directions

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Abstract: The purpose of this study was to answer the following questions: (a) What are the theoretical perspectives driving science teacher preparation programs in Lebanon? (b) What are the requirements of Lebanese science teacher preparation programs? and (c) What are the similarities and differences among the variety of science teacher preparation programs offered in Lebanon? Data sources for this study included: official governmental documents and mandates related to teacher preparation; institutional catalogues and syllabi of courses; and interviews with science education professors. Results of the study showed that teacher preparation programs in Lebanon are characterized by: (a) post-graduate programs that prepare secondary teachers with significant amount of science background; (b) three and 4-year programs that prepare elementary classroom teachers or science/mathematics teachers; (c) the absence of university level programs for the preparation of intermediate school science teachers; (d) the requirement of a thesis in many of the programs; (e) a lack of emphasis on field work; and (f) the adoption of an orientation that has some characteristics of the academic and technological orientations to teacher preparation.

Education in Lebanon has a special flavor. The freedom of education guaranteed by the Lebanese constitution has allowed private schools, universities, and colleges to flourish. These institutions are affiliated with international and national religious, independent non-profit, and independent for-profit organizations. Presently, at the tertiary level, there are 19 private universities or colleges, nine of which offer science teacher education programs. Also, several 2-year private colleges are involved in science teacher preparation. Likewise, the Lebanese government is involved in science teacher preparation through the Lebanese University, the Center for Educational Research and Development (CERD), and the Ministry of Technical and Vocational Education.

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Colleges and universities in Lebanon can be classified into four categories based on the higher education model they follow: American, French, Arab, or Lebanese. The only university following an Arab model of higher education (The Arab University) does not offer science teacher education programs as of yet. The universities that follow an American model or a French model have programs patterned after similar ones in universities in the US or in France (Freiha, 1997).

The French model is different from the American model in that it is organized by years rather than by courses. In addition, programs in institutions that follow the French model are characterized by early specialization, absence of a liberal arts core, and lack of electives. The Lebanese model, however, has its own distinct character with ideas derived from more than one of the other models.

The preparation of science teachers at the elementary, middle school, and high school levels is integral to the missions of private as well as public Lebanese institutions of higher education. Competition among the institutions has created a wide variety of science teacher preparation programs, each with its own theoretical perspective, set of requirements, and characteristics, but each preparing science teachers for Lebanese schools and in some cases for schools in the Arab region. These institutions prepare science teachers in a variety of programs and institutional structural units and offer different types of degrees. Table 1 presents the names of Lebanese colleges and universities that offer education programs along with the degrees they offer.

To understand the variety of teacher preparation programs offered by universities in Lebanon requires an understanding of the Lebanese pre-college educational ladder. In 1967, Lebanese Law Number 9099 instituted four stages in the pre-college educational system: preschool, elementary, intermediate, and secondary. Law Number 10227 (1997) maintained these four stages but refined the number of years required at each. The preschool stage consists of two years, the elementary stage consists of six years divided into two 3-year cycles, and the intermediate and secondary levels consist of three years each, for a total of 14 years.

Lebanese students are required to follow the Lebanese curriculum. As Figure 1 demonstrates, this curriculum is common for all students until Grade 10. In Grade 11 students may choose to follow the humanities stream or the science stream. Those who choose the humanities stream may choose to continue with the humanities and literature stream or follow the social sciences and economics stream in Grade 12. The students who choose the science stream in Grade 11 level may choose the general sciences stream or the life sciences stream in Grade 12. Each stream consists of a fixed number of subjects that all students who choose the stream are required to follow.

Table 1. Lebanese Colleges and Universities that Prepare Science Teachers, Degrees They Offer, and Number of Years of Study

Institution	Degree*	Duration
American University of Beirut	BA	3 years
	Teaching Diploma	1 year
Haigazian University	BA	3 years
	Normal Diploma	1 year
Higher College for Teacher Preparation	Education License	4 years
Lebanese University	Education License	4 years
	Diploma of Higher Studies	2 years
	Certificate of Qualification	2 years
Lebanese American University	BA	3 years
	Teaching Diploma	1 year
Middle East College	BA	3 years
Notre Dame University	Teaching Diploma	1 year
University of Saint Joseph	Education License	4 years
University of Balamand	Education License	1 year
	Teaching Diploma	4 years
University of the Holy Spirit in Kaslik	Education License	4 years
	University License	3 years

*The Teaching Diploma, Normal Diploma, Diploma in Higher Studies, and Certificate of Qualification require an undergraduate science degree. Admission to universities requires the Lebanese Baccalaureate. Lebanese students holding the Baccalaureate are admitted as sophomores in universities that follow an American model.

There is no possibility of elective courses within the stream. All students take science at all levels. However, the number of periods per week varies with the level and stream the student selects. Table 2 presents the number of periods of science at each grade level and in each stream. The "General Science" designation refers to courses that include life, physical, and Earth science. The "Science" designation at the Grade 11 level refers to the name

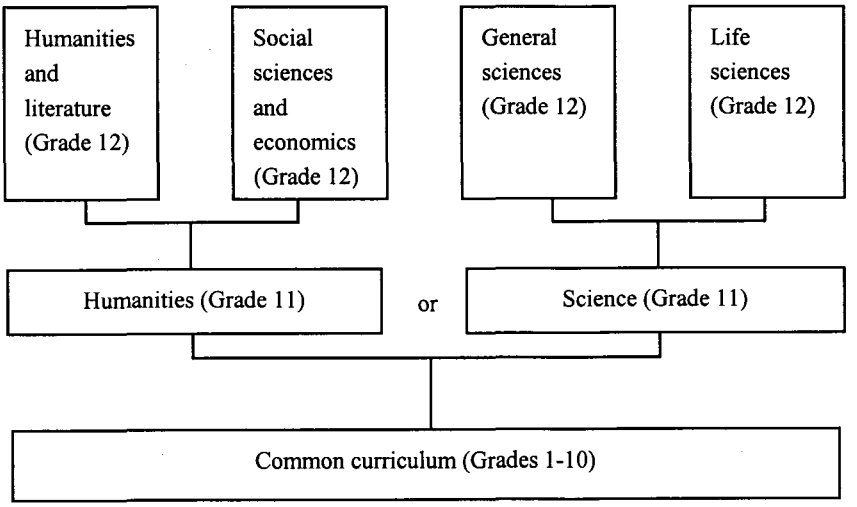

Figure 1. Structure of the Lebanese Educational Ladder

of the stream, as described above. Note that the 1.5 periods of chemistry and physics at Grade 7 represents a bureaucratic compromise, typically solved by having the same teacher for both subjects; the teacher then devotes the required time to each course.

Table 2. Number of Periods per Week of General Science, Biology, Chemistry, and Biology Taught at Each Grade Level of the Lebanese Educational System

Grade	1	2	3	4	5	6	7	8	9	10	11		12			
											S	H	GS	L	SS	H
General Science	2	2	3	4	4	5										
Biology							3	2	2	2	2			6		
Chemistry							1.5	2	2	2	3		4	5		
Physics							1.5	2	2	3	5		7	5		
Science Literacy												3			4	3
Total	2	2	3	4	4	5	6	6	6	7	10	3	11	16	4	3

S = Science, H = Humanities, GS = General Sciences, L = Life Sciences,
SS = Social Sciences and Economics

Lebanese students sit for official national examinations at the end of the intermediate and the secondary stages. The official examination taken at the end of the intermediate stage is common to all students in the general

education[1] system. However, the examination taken at the end of the secondary education stage, called the Lebanese Baccalaureate and required for admission to universities, is divided into four different sections: humanities and literature, social sciences and economics, general sciences, life sciences.

Lebanon is presently in the midst of educational reform. The Lebanese Government has enacted a new educational ladder and CERD is preoccupied with developing new curricula for all subject areas at all pre-college levels (CERD, 1995; Public Law Number 10227, 1997). As a result, it is essential to understand the current status of science teacher preparation. Additionally, sharing ideas about the status and future directions of science teacher preparation in Lebanon with an international audience may help create a dialogue about teacher preparation worldwide. Consequently, the purpose of this study was to answer the following questions:

1. What are the theoretical perspectives driving science teacher preparation in Lebanon?
2. What are the requirements of Lebanese science teacher preparation programs?
3. What are the similarities and differences among the Lebanese science teacher preparation programs?
4. What policies drive Lebanese science teacher preparation programs?
5. What are the future directions of science teacher preparation in Lebanon?

LITERATURE REVIEW

Research studies have focused on the structural components of Lebanese teacher education programs without neglecting conceptual components. Most of these studies investigated teacher education in general with only a few focusing on science teacher education. The most recent studies by Farah-Sarkis (1997) and Freiha (1997) found that most programs emphasize theoretical rather than practical issues. Moreover, Freiha found that the nature of these programs was influenced by the model of higher education espoused at the institution in which they were offered. Consequently, programs at American style institutions were similar to programs offered at American universities while those at French style institutions were patterned after similar ones in French universities. Farah-Sarkis, on the other hand, found that there was no balance between theoretical and practical components of the Lebanese teacher education programs, with the percentage of time dedicated to practical work ranging from 5.2% to 25%.

[1] There are two parallel systems of education in Lebanon: General and Technical.

Chapter 5

Science Teacher Education in Pakistan

Policies and Practices

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Abstract: The chapter addresses the problems faced by science teacher educators in Pakistan. We first discuss the historical background of science education development to give readers an understanding of the Pakistani perspective. We argue that teacher education programs are caught up in a vicious cycle. On the one hand, increasing the number of qualified teachers is a natural need for the expanding system of education, and, on the other hand, there is a genuine concern for the maintenance of quality in the education imparted. Obviously, if teacher education programs are not carried out with care, quality aspects will be compromised as in the past. This requires an overall improvement in (a) the quality of course content, (b) the minimum duration, and (c) the admission requirements for different programs of teacher education. We discuss the disparity between pronounced policies of teacher education and their actual implementation and suggest methods to improve science teacher education.

Science teacher education in Pakistan is confronted with many problems. Some problems are common to many other countries in the world, while some are unique to a developing country like Pakistan, whose education system has not yet been established on realistic footings. These problems can be fully understood in the historical and social perspectives of the education system in general. Pakistan as an independent state came into being just half a century ago. The nation celebrated its 50th anniversary on August 14, 1997.

Thus the education system of the country does not have a long history, although it is older than the nation itself. The British rulers introduced this education system during the second half of the nineteenth century when Pakistan was still part of the Indo-Pak sub-continent. This does not mean that there was no education system in the sub-continent prior to the establishment of the English education system. The fact is that the

S.K. Abell (ed.), Science Teacher Education, 75–92.

indigenous system of education was replaced by the English system of education. The British system was installed to achieve colonial purposes. This system was designed to produce a literate manpower to assist the colonial rulers at the lower levels of governmental and economic administration. Higher level jobs were reserved for English men only. As Hayes (1987) pointed out, such an education system was meant only for the privileged few, who were supposed to govern the masses rather than to serve them. Because the real intention was to produce white-collar workers, undue emphasis was placed on liberal arts and non-professional education. This system served the narrow utilitarian purpose of the colonial rulers very well, but had no room for nourishment of the individuality, creativity, or intellectual capacities of learners. The same was reflected in the curricula and textbooks, which were rigidly oriented towards memorization and passing examinations.

Science as a school subject was not introduced in the British system of education in Pakistan at the beginning, although it had been fighting for its recognition for quite a considerable time. Later, science subjects were introduced from top-down, first at the higher level and then at the lower level. The science taught at the secondary level was didactic and theoretical in nature. As far as the primary and middle school levels were concerned, practically no science was taught until the 1950s. The main emphasis at this level of education was upon reading, writing, and arithmetic--the traditional three R's (Government of Pakistan, 1975). Because science education had very little or no emphasis in the curriculum, there was no clear policy or system of education for teachers in science.

Soon after independence, it was realized that Pakistan's education system was not based on realistic objectives. The system, with an emphasis on the three R's and liberal arts, was more geared to serving colonial purposes. In order to serve the purposes of an independent state, the education system needed an overhauling and restructuring, with a greater emphasis on science and technology. It was also realized that the curricula at various level of education lamentably ignored science, technical, and vocational subjects. The first Pakistan Education Conference, held in 1947 in Karachi, prepared the ground for major changes in the education system of the country. The conference received a message from the founder and first Governor General of Pakistan, Muhammad Ali Jinnah, emphasizing the need for giving the education system of the country a scientific and technical base in order to build up the economic life of the newly liberated state. It was believed that a strong science and technological education was imperative for achieving economic development and prosperity. During the same conference, a Committee on Scientific Research and Technical Education was convened. The committee discussed the problems and issues of science and technical

education and recommended that every effort be made to promote fundamental as well as industrial research (Government of Pakistan, 1947). Ironically, the agenda before the committee was to discuss problems and issues of science, technology, and research at the higher level. These deliberations were not related to science education, particularly at the school level, nor was the issue of science teacher preparation placed on the agenda of the conference.

The second effort in this regard was the setting up of a commission in 1959 that was assigned the job of recommending measures to improve the system of education in Pakistan. Observing the condition and status of science education in the country, the commission recommended that, "In an age when science and applied technology determine the rate of progress of the nations, the teaching of science and mathematics be given a strong base in our schools" (Government of Pakistan, 1959, p. 122). The commission recommended that science and mathematics education be made compulsory for grades 6-10. The commission also noted an imbalance between different components of the curriculum at the primary level. The commission recommended that an equal emphasis be given to science, mathematics, and the liberal arts at the primary level. Following the recommendations by the commission, nature study was introduced at the elementary level to familiarize students with the environment by direct observation. The component of science, however, remained very weak, and in actual classroom practice the major emphasis still remained on the three R's. Theoretically, in the late fifties and early sixties, science education was made a compulsory part of the curriculum for grades 1-8. However, the quality of instruction in science at all levels remained far from satisfactory. The reason for this poor quality of instruction can be traced to the lack of proper education of science teachers.

The first policy that focused science education as discipline of human inquiry was the National Education Policy 1979 (Government of Pakistan, 1979). This policy discussed science education as a separate component of secondary education and emphasized its development on sound footing. Regarding the quality of science instruction in the country, the policy observed:

> In spite of several curricular reforms in science education, the quality of instruction in science education, particularly at the pre-university levels, has not improved considerably. This is so because science is still being taught as a "dogma". Very little curiosity in scientific inquiry, initiative and involvement in understanding the scientific concepts and processes are emphasized. (p.35)

This policy was different than other previously announced policies in the sense that, for the first time, the quality of pre-university science education was discussed and measures were recommended to improve it. In previous policies the main emphasis had been on the development and improvement of science and technology education at the university level. This was based on the assumption that to achieve economic progress, it was more important to give emphasis to secondary and higher education than to primary and middle level education. Measures adopted to improve school science education and their impact will be discussed subsequently.

THE CURRENT STATUS OF SCIENCE EDUCATION IN PAKISTANI SCHOOLS

The structure of the Pakistani education system is depicted in Figure 1. At present, science education in Pakistan is compulsory at elementary (primary and middle) and optional at the secondary levels. From grades 1-8, science is supposed to be taught in an integrated manner, comprising some components from biology, chemistry, physics, and Earth science. At the primary level, science should occupy about 12% of the total school time. At the middle school level, 13-15% of instructional time is allocated to science. At the secondary level, about 12-14% of the time is allotted to each science subject-- physics, chemistry, and biology--with a total time for science being about 40%. The purpose of science education at the elementary level is to familiarize students with nature and their environment. At the secondary levels, grades 9 and 10, science is taught in the form of separate subjects--physics, chemistry, and biology. The main purpose of secondary and higher secondary levels of education is to prepare students for tertiary education in different scientific disciplines, largely in the engineering and medical fields. Very few students take science subjects with a particular interest and purpose of following pure science at the higher level. A large teaching force has been required to teach science, not only at the primary and middle levels where science is a compulsory component, but at the secondary level as well, where it is optional. Such a teaching force is not available even at this time, nor do teachers who have been entrusted with the job of science teaching have adequate preparation to meet the demands of teaching science in the changing world. A cursory look on the teacher education program in Pakistan will reveal this fact.

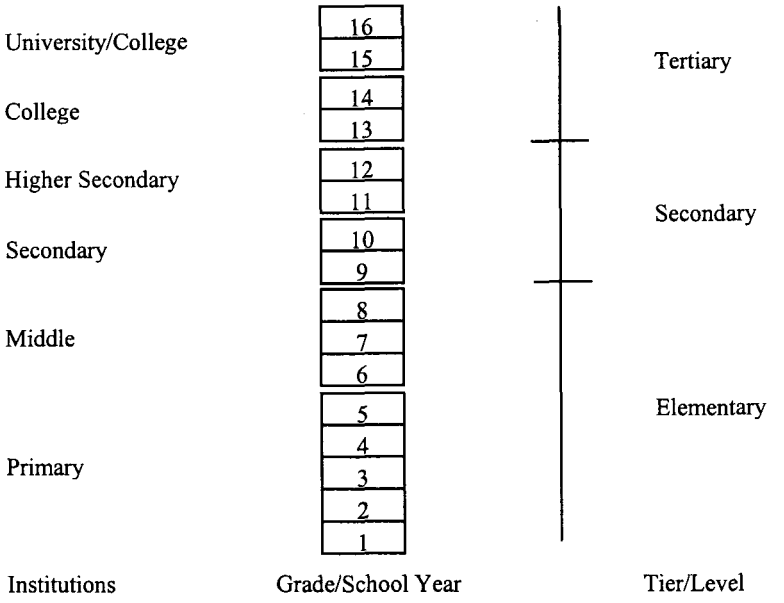

Figure 1. The structure of Pakistan's education system

Preparation and Qualification of Teachers

After independence, and as a result of recommendations made by various commissions, a rapid expansion in the education system in Pakistan was made. This speedy growth of the education system has been accompanied by important advances in teacher education. The general strategy in teacher preparation programs has been directed by two requirements: (a) increase the number of teachers, especially at the primary level, and (b) improve the quality of teacher preparation. On both accounts substantial progress has been made. Yet, when viewed from the overall requirements of teachers at various educational levels, teacher preparation programs have suffered from stagnation and slow growth. The Education Conference of 1947 emphasized the need for a properly educated and reasonably well paid teaching force, and recommended that provinces should take necessary steps in this regard. Similar emphasis has been placed on teacher education in all subsequent policies and plans. The report of the National Commission on Education (Government of Pakistan, 1959), in particular, identified the gaps in teacher preparation programs, and called for a massive increase in such programs. Regarding the preparation of teachers, the commission was of the view that the duration of preservice education of teachers at the primary level be extended to two years, instead of one year. However, the commission