

AN INVESTIGATION OF THE PROFESSIONAL NEEDS
OF SCIENCE TEACHERS IN SECONDARY
SCHOOLS IN BAHRAIN



by

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APPROVED:

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Title: AN INVESTIGATION OF THE PROFESSIONAL NEEDS OF
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A complex issue confronting science education relates the importance of staff development in the successful implementation of new curricula to the criticism that in-service programs are often unsuccessful--due, in part, to the failure of these programs to address specific curriculum-related teacher needs.

This study is relevant to this dilemma through investigating Bahraini secondary school science teachers' (a) perception of need for specific science-teaching competencies, (b) perception of importance of these competencies in teaching Bahrain's recently-adopted curriculum, and (c) perception of need and importance in relationship to certain personal and institutional factors.

Data were collected through a questionnaire distributed to all secondary school science teachers. The data

analysis consisted of frequency rankings for importance and need, analyses of variance, and Tukey HSD Tests.

The results indicated that the teachers perceived greatest need in the areas of scientific knowledge, laboratory skills, and science instructional materials. Less need was perceived in the areas of teaching strategies, planning, evaluation, and delivering and managing science instruction.

The teachers attached greater importance to the areas of scientific knowledge, laboratory skills, and some aspects of delivering science instruction. Less importance was assigned to the areas of planning, instructional strategies, evaluation, managing science instruction, and science teacher self-improvement.

The two competency categories perceived to be of greatest need overall were, respectively, science teacher self-improvement and administering science instructional facilities and equipment.

The two competency categories perceived to be of greatest importance overall were, respectively, administering science instructional facilities and equipment and science teacher self-improvement.

Although years of experience in teaching and years of experience in teaching science were powerful variables,

major in college and subject area taught only slightly influenced perceptions of need and importance; teaching diploma attainment was not a factor in perception of either need or importance.

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CHAPTER I

THE PROBLEM

Introduction

Bahrain is an independent Arab country located midway in the Arabian Gulf, approximately 30 miles from the east coast of Saudi Arabia. It is composed of an archipelago of 33 islands. The main islands are: Bahrain, Muharraq, Sitra, Nabi Saleh, Jida, Hawar, and Umm Suban. A causeway linking Bahrain to Saudi Arabia has been constructed and will be opened in 1986. The total area of the State of Bahrain is approximately 660 square kilometers with the largest island, Bahrain, representing approximately 85% of the land area. The capital, Manama, is located on the island of Bahrain, as are the main port, refinery, and business and commercial centers. Due to the existence of two vital elements of life--water and agriculture--in this country, Sumerian legends have referred to Bahrain as "the land of life." It is believed that the name "Bahrain," which means two seas in Arabic, was derived from this Sumerian term (Ministry of Information, 1983).

Historically, Bahrain has been an important commercial center located on the major trade route between the East and the West. In addition, it has been known for its pearling industry, sea food, and agriculture. The Gulf has been famous for its pearling since the days of the Babylonians who used to call the pearls "fish eyes" (Khuri, 1980). Initially, pearling was a luxury but its economic importance has been recognized since the eighteenth century. Agriculture in Bahrain consists of some vegetable and fruit crops with a major crop provided by the date palm.

Oil was discovered in Bahrain in 1930 by the Bahrain Petroleum Company (BAPCO), a subsidiary of Standard Oil of California. This was the first such discovery in the Gulf region. Parallel discoveries occurred in the neighboring areas of Saudi Arabia and Kuwait in 1938, Qatar in 1939, Abu Dhabi in 1958, Dubai in 1966, and Oman in 1967. The discovery of oil and the corresponding industrial development has had an immense impact on the socioeconomic status of the country. The oil industry attracted workers to steady and stable jobs which other industries did not provide.

With the advent of oil, the pearl industry began to decline. Khuri (1980, p. 135) states:

Boasting about 2,000 boats before the development of oil, Bahrain averaged 500 afterward, which dropped to 192 in 1945, 12 in 1953, and none in the 1960s. The number of boats constructed in Bahrain dropped from 100 in 1928 to 8 in 1936, and to even fewer in the following years.

The demand for dates decreased as the pearl industry was collapsing, but the remaining agricultural production increased. This pattern has been attributed to a general change in the dietary habits of the population.

Oil also had an impact on the structure of the society. Bahrainies, who had acquired education earlier than the other citizens in neighboring areas, sought employment in the oil industry outside Bahrain. Inside Bahrain some areas were deserted and others lost population and importance as people moved to resettle in Manama and other large towns.

Although Bahrain enjoyed a period of prosperity before the oil drilling began, the true foundations of modern Bahrain are laid on its oil industry. However, the oil output from the Jabel Al-Dukan field has been declining for some years and Bahrain's crude oil production, which peaked at 76,000 b/d in 1970, has since fallen to 46,000 b/d in 1981 and 44,000 b/d in 1982. It is expected that the output will continue to decrease by a rate of 4% per year. In 1983 the Organization of Arab Petroleum Exporting Countries (OAPEC) listed the life of Bahrain's

known reserve, based upon its current production levels, to be 12 years ("Bahrain," 1983/1984). Due to this, Bahrain is now concentrating on oil refining and on natural gas production. Attempts to further diversify the economy have involved the construction of a variety of industrial projects including an aluminum smelter, dry dock, petrochemical plant, and gas liquefaction plant.

In Bahrain, there are now four institutions of higher education: the Bahrain University College of Science, Art and Education (BUC); The College of Medical Sciences; The Gulf College of Technology; and the Hotel and Catering Training Center. A Gulf University also has been established. At present, the training of teachers is done at the BUC. In the future, the Gulf University will share in the responsibility for the preparation of teachers.

Reforms in education in general, and in science education in particular, began in the Arab countries in the early '70s. The Arab League Educational, Cultural, and Scientific Organization (ALESCO) played an important role in this process by developing a variety of programs in science education. There have also been local and regional efforts for the improvement of this field of study including: (a) regional efforts for the development of

mathematics, physical science, biology, chemistry, and integrated science curricula; (b) efforts at stressing the importance of environmental education; and (c) establishment of regional institutions for updating and developing science education (Selim, 1978).

The past 8 years in Bahrain have been marked by efforts to revise and update the public-school science curriculum. Committees consisting of teachers, supervisors, and university professors were formed to analyze the existing program of studies and propose a plan for a new science curriculum. Their tasks included writing objectives, selecting instructional materials, designing activities, and writing textbooks and teachers' guides. The process of curriculum reform began with intermediate education and gradually proceeded through the primary and secondary curricula.

The curriculum for the first intermediate level was implemented in 1977-78, the curriculum for the second intermediate level in 1978-79, and the curriculum for the third intermediate level in 1979-80. On the elementary level, the first- and third-level curricula were implemented in 1978-79; the second- and fourth-level curricula were implemented in 1979-80; the fifth-level curriculum in 1980-81; and the sixth-level curricula in

1981-82. Concerning secondary education, preparation for the new curriculum started in April 1979 and finished in February 1980. The implementation was done without a trial, or pilot study, for the first secondary level in 1980-81, for the second secondary level in 1981-82, and for the third secondary level in 1982-83. The full implementation of a new science curriculum through all school levels was completed in the school year 1982-83.

Background of the Problem

One of the reasons leading to changes within the science curriculum concerned the lack of a process approach to the learning of science. Curriculum was content-oriented and placed little emphasis on laboratory work. The new curriculum was designed to incorporate a process approach to science teaching and laboratory activities; and this is prominent both in the student texts and the teachers' guides. In addition, in-service programs have been designed and implemented to familiarize teachers with the new science curriculum.

Research on in-service education demonstrates that directly addressing the needs of teachers is a factor contributing to the success of such a task (Fullan, 1982; Horn, 1976; Voelker, 1977). Other factors that have been

identified include: the provision of on-site assistance to teachers (Joyce, Hersh, & McKibbin, 1983), the focus on objectives, the use of curricula that can serve as a model, the provision for hands-on experience, the use of concrete teaching materials, and the incorporation of in-service into a continuous staff development program (Orlich, 1984).

Fullan (1982) holds that a successful implementation of a new curriculum requires a change in the outlook, feelings, and performance of the teachers. This general statement is of particular importance to the new science curriculum in Bahrain because of its emphasis on the teaching of the process of science. This approach to science instruction requires the teacher to play a different role in the classroom, using new methods to conduct and manage the class and employing new teaching strategies. Teachers who are not familiar and comfortable with these new techniques and strategies will likely feel frustrated as they try to teach the new curriculum.

According to Howe (1978):

This is only natural. Teachers view themselves as professionals who have been trained to make instructional decisions which will assist student learning and growth. While curriculum decisions are usually made at higher level and evaluation often done by others, most teachers feel that decisions about how the curriculum is to be taught belong to them. Teachers regard the planning and execution of

these daily activities as central to their work in the classroom; when they are asked to give up these activities and adopt a new set of attitudes and behaviors, stress and role conflict are inevitable. (p. 31)

Statement of Purpose

The main purpose of this study was to identify the professional needs that are critically felt by secondary science teachers in Bahrain. These needs were analyzed in terms of their relevance to the new science curriculum. Moreover, the relationship between the identified needs and the related variables of years of experience, the science subject taught, and the nature of pre-service preparation were also investigated.

There is a large body of literature describing the importance of the teacher's role in curriculum implementation. Fullan (1982) comments:

The essence of educational change consists of learning new ways of thinking and doing, new skills, knowledge, attitudes, etc. . . . [it] depends on what teachers do and think . . . if educational change is to happen, it will require that teachers understand themselves and be understood by others. (pp. 66, 107)

Hence, staff development is one of the important factors in any educational change. Joyce et al. (1983) explain this by saying:

We want to make it very clear that all but the most mild changes require training in content and process. The messages of research on curriculum implementation

are unequivocal; very little implementation will take place even in positive environment by highly motivated people unless training is provided. (p. 137)

A successful implementation of the new science program in the secondary schools in Bahrain requires a careful study of the new role that is required of the teachers. Identifying the perceived needs of the science teachers may provide a guideline for such an examination. Furthermore, by analyzing the needs of the science teachers with relevance to other variables, specific in-service programs can be designed to meet these needs.

Statement of the Problem

The problem addressed by this study was: What are the perceived needs of identified science teaching competencies by secondary science teachers in Bahrain, and what importance do they attach to these competencies in the teaching of the new science curriculum. In regard to this problem the following research questions were posed:

1. What professional competencies of science instruction are most frequently identified as being of moderate or great need by secondary science teachers in Bahrain?

2. What professional competencies of science instruction are most frequently identified as being of

moderate or great importance to the teaching of the new science curriculum by secondary science teachers in Bahrain?

3. Which categories of the competencies are perceived as being of greatest need, and which are perceived as being of greatest importance?

4. Is the perception of professional competencies of science instruction by secondary science teachers in Bahrain related to teaching experience, nature of preparation and qualification, and subject area taught?

Importance of the Study

With every educational change there are feelings of stress, frustration, and dissatisfaction on behalf of the teachers. Through identifying the professional needs of the science teachers, in-service programs can be designed to address these feelings. In addition, this study can provide feedback to the pre-service teacher training program by identifying the competencies which are considered highly important and those which are highly needed.

The following aspects of this research are also important:

1. It may provide a guideline toward a successful implementation of the new science curriculum.

2. The data may provide information about the influence of variables, such as years of experience and the nature of preparation, upon the teachers' perceptions regarding the teaching of science. This information can be utilized to design proper in-service programs for each group of teachers.

Definition of Terms

Science Teacher Need. According to Moore (1977), science teacher need concerns:

A conscious drive, interest, or desire on the part of the science teacher which is necessary for the improvement of science teaching. This conscious drive, interest, or desire results, in part, from the science teacher's interaction with students and is perceived by the science teacher as the assistance which is needed in order to do a better job of teaching science. (p. 145)

In-Service Education. As one of the elements of staff development, in-service education encompasses such elements as "implementing curricula, improving skills, expanding subject matter knowledge, planning and organizing instruction, and increasing personal effectiveness" (Dale, 1982, p. 21).

CHAPTER II

REVIEW OF LITERATURE

Education in Bahrain

General

Education in Bahrain in its current form began in 1919 with the establishment of the first elementary school for boys. The year 1927 marked the establishment of a governmental institution to direct education. The first school for girls opened in 1929. The number of schools continued to increase until it reached 57 schools for girls and 70 schools for boys in 1983. The number of students increased from 27,843 for the year 1962-63 to 76,609 for the year 1982-83. The number of teachers increased from 1,086 to 4,434 during the same period.

The policy of the Ministry of Education is based on the following principles:

First: to make education available for all those who are school age in all parts of the country. Second: to renew the quality of education so that it matches the needs of the learners as well as the social and economical needs of the development of the country. (Ministry of Education, 1983, p. 2)

Elementary and Intermediate Education in Bahrain

The teaching of science begins in the first elementary grade. The school day in the elementary school is divided into periods during which the following subjects are taught: religious education, Arabic language, English language, mathematics, elementary science and health, social studies (geography and history), art education, physical education, and music. The number of periods each week devoted to science begins with two periods, each 45 minutes in duration during the first three grades, and increases to three periods in the next three grades; in the three intermediate grades, the number of periods devoted to science increases to four.

Secondary Education in Bahrain

Secondary education in Bahrain includes the 10th, 11th, and 12th grades. Tables 1 and 2 represent the fluctuations in enrollment and the numbers of graduates in secondary education. The secondary curriculum is divided into subject matter divisions, termed sections, with students having the option of being enrolled in any section depending on their interests and abilities. Students in each section follow the same daily schedule,

TABLE 1. Enrollment in General Secondary Education by
Grade and Gender for the 1974-75 Through 1983-84
Scholastic Years

Enrollment by Gender and Scholastic Year		Grades			Total
		Grade 10	Grade 11	Grade 12	
1974-75:	Male	1,440	957	820	3,217
	Female	1,683	1,028	1,107	3,818
1975-76:	Male	1,246	1,063	949	3,258
	Female	1,551	1,187	1,158	3,896
1976-77:	Male	1,293	1,011	1,002	3,306
	Female	1,534	1,185	1,240	3,959
1977-78:	Male	1,582	980	1,006	3,568
	Female	1,584	1,330	1,277	4,191
1978-79:	Male	1,563	1,290	1,148	4,001
	Female	1,667	1,378	1,380	4,425
1979-80:	Male	510	1,298	1,319	3,127
	Female	598	1,328	1,346	3,272
1980-81:	Male	775	424	1,500	2,699
	Female	1,092	487	1,359	2,938
1981-82:	Male	754	687	753	2,194
	Female	866	1,013	607	2,486
1982-83:	Male	690	699	705	2,094
	Female	1,052	856	998	2,906
1983-84:	Male	796	662	730	2,188
	Female	1,556	992	883	3,431

Note. Table originally in Arabic; translated from
Educational Statistics for the Years 1983-84 (p. 121) by
Ministry of Education Statistics Section, 1984, Manama,
Bahrain: Author. Copyright 1984 by Ministry of Education
Statistics Section.

TABLE 2. Graduates of General Secondary Education by
Branch and Gender for the 1974-75 Through 1983-84
Scholastic Years

Graduates by Gender and Scholastic Year	Number of Graduates by Branch		
	Arts	Science	Total
1974-75: Male	161	343	504
Female	378	270	648
Total	539	613	1,152
1975-76: Male	328	389	717
Female	549	354	903
Total	877	743	1,620
1976-77: Male	297	417	714
Female	524	399	923
Total	821	816	1,637
1977-78: Male	259	301	560
Female	528	443	971
Total	787	744	1,531
1978-79: Male	328	440	768
Female	642	515	1,157
Total	970	955	1,925
1979-80: Male	419	467	886
Female	698	464	1,162
Total	1,117	931	2,048
1980-81: Male	466	500	966
Female	736	404	1,140
Total	1,202	904	2,106
1981-82: Male	321	130	451
Female	305	258	563
Total	626	388	1,014
1982-83: Male	185	417	602
Female	363	502	865
Total	548	919	1,467
1983-84: Male	151	400	551
Female	255	551	806
Total	406	951	1,357

Note. Table originally in Arabic; translated from
Educational Statistics for the Years 1983-84 (p. 120) by
Ministry of Education Statistics Section, 1984, Manama,
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Statistics Section.

generally taking most of their subjects in the same classroom. Special facilities, that may be used by students from a variety of sections, are provided for classes which involve laboratory activities.

At the present time, the secondary curriculum consists of 10 sections as follows:

- First: Scientific
- Second: Literary
- Third: Commercial
- Fourth: Nursing
- Fifth: Industrial Education
- Sixth: Hotel Management
- Seventh: Textiles
- Eighth: Agriculture
- Ninth: Music
- Tenth: Typing

Each section is further divided into branches. For example, the scientific section is divided into two branches: first, physics and mathematics; and second, biology and chemistry. Tables 3 and 4 provide additional information about the secondary education in Bahrain for the scientific and literary sections for the year 1983-84.

Secondary education has experienced a period of change over the past 6 years as new sections have been

TABLE 3. Enrollment in General Secondary Education by Grade, Age, and Gender for the 1983-84 Scholastic Year

Gender by Age	Arts									Science								
	Grade 10		Grade 11		Grade 12		Total			Grade 10		Grade 11		Grade 12		Total		
	E	R	P	R	P	R	E	P	R	E	R	P	R	P	R	E	P	R
12 Years																		
Male	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Female	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
13 Years																		
Male	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Female	---	---	---	---	---	---	---	---	---	2	---	---	---	---	---	2	---	---
14 Years																		
Male	2	---	---	---	---	---	2	---	---	15	---	---	---	---	---	15	---	---
Female	22	---	2	---	---	---	22	2	---	57	---	1	---	---	---	57	1	---
15 Years																		
Male	21	---	3	---	---	---	21	3	---	142	1	14	---	---	---	142	14	1
Female	160	1	9	---	---	---	160	9	1	359	---	57	---	2	---	359	59	---
16 Years																		
Male	65	---	19	---	---	---	65	19	---	215	3	132	1	13	---	215	145	4
Female	201	1	80	---	4	---	201	84	1	201	5	272	---	27	---	201	299	5
17 Years																		
Male	67	4	36	---	19	---	67	55	4	89	12	235	4	118	1	89	353	17
Female	176	4	114	---	62	---	176	176	4	112	4	212	3	238	5	112	450	12
18 Years																		
Male	46	3	37	---	50	2	46	87	5	33	6	99	6	213	8	33	312	20
Female	131	5	98	---	98	---	131	196	5	37	2	60	2	202	22	37	262	26
19 Years																		
Males	30	2	12	---	51	2	30	63	4	14	---	31	2	96	28	14	127	30
Females	35	3	36	5	66	3	35	102	11	14	---	21	---	81	10	14	102	10
20 Years																		
Males	13	---	5	---	29	1	13	34	1	5	1	15	2	34	9	5	49	12
Females	16	1	11	---	17	2	16	28	3	2	---	4	---	22	3	2	26	3
21 Years																		
Male	7	---	5	---	22	4	7	27	4	---	---	4	---	22	8	---	26	8
Female	2	2	1	2	7	3	2	8	7	1	---	2	---	7	2	1	9	2
Total																		
Male	251	9	117	---	171	9	251	288	18	513	23	530	15	496	54	513	1026	92
Female	743	17	351	7	254	8	743	605	32	785	11	629	5	579	42	785	1208	58

Note. E = New Entrants; R = Repeaters; P = Promotion. Table originally in Arabic; translated from Educational Statistics for the Years 1983-84 (p. 114) by Ministry of Education Statistics Section, 1984, Manama, Bahrain: Author. Copyright 1984 by Ministry of Education Statistics Section.

TABLE 4. Number of Students, Classrooms, and Average Size Per Class in General Secondary Education by Grade and Gender for Scholastic Year 1983-84

Grade	Number of Students			Number of Classrooms			Average Size Per Class		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Grade 10									
Science	536	796	1,332	18	27	45	30	29	30
Arts	260	760	1,020	9	21	30	29	36	34
Total	796	1,556	2,352	27	48	75	29	32	31
Grade 11									
Science	545	634	1,179	18	20	38	30	32	31
Arts	117	358	475	5	12	17	23	30	28
Total	662	992	1,654	23	32	55	29	31	30
Grade 12									
Science	550	621	1,171	19	19	38	29	33	31
Arts	180	262	442	7	10	17	26	26	26
Total	730	883	1,613	26	29	55	28	30	29
Combined Total									
Science	1,631	2,051	3,682	55	66	121	30	31	30
Arts	557	1,380	1,937	21	43	64	27	32	30
Total	2,188	3,431	5,619	76	109	185	29	31	30

Note. Table originally in Arabic; translated from Educational Statistics for the Years 1983-84 (p. 113) by Ministry of Education Statistics Section, 1984, Manama, Bahrain:
 Author. Copyright 1984 by Ministry of Education Statistics Section.

introduced. According to the Ministry of Education (1983), the major factors contributing to this change have been the extension of intermediate education to cover 3 years instead of 2, and the need to modify the secondary school curriculum in order to eliminate problems of content as revealed by comprehensive evaluation efforts.

Between 1976 and 1979, intermediate education, formerly consisting of Grades 7 and 8, was extended to include Grade 9. The increased educational level of the students entering the secondary school necessitated changes in both organization and structure. Furthermore, the current evaluation results suggested that the existing curriculum was overly theoretical and unresponsive to the needs of the local environment.

The decision of the Council of Ministry, to create more sections of secondary education, was intended to create additional job opportunities for youth by enhancing the ability of the secondary school to meet the demands of the job market for qualified Bahraini graduates, and to make the system more flexible in meeting the diverse abilities and interests of students.

According to the Bubshait (1981), the following are among the most important characteristics of the new secondary curricula as related to the sciences:

1. A curriculum based on the study of science subjects within the context of the local environment of Bahrain and the Arabian Gulf.
2. An increase in emphasis within the study of science to the application of science in different aspects of daily life.
3. Placement of emphasis on experimental skills in science.
4. Training in the use of the scientific method to solve problems.

The following methods of instruction were suggested for teaching the new secondary curricula (Bubshait, 1981, p. 9):

1. Stressing the role of students in the process of teaching and learning by encouraging them to effectively participate in the learning activities.
2. Encouraging the involvement and creativity of both students and teachers.
3. Paying attention to individual differences by dividing language and science classrooms into two sections to facilitate laboratory use and to allow for opportunities to solve individual student problems.

4. Emphasizing the applications of scientific principles as well as the role of experimentation in studying science.

Tables 5 and 6 outline the present curriculum for the science sections.

TABLE 5. The Study Plan of the Scientific Section for General Secondary Education

Subjects Required of Every Student	Grade 10 Periods/Week	Grade 11 Periods/Week	Grade 12 Periods/Week
Religious Education	2	2	2
Arabic Language	7	5	5
English Language	9	8	7
Social Studies	2	-	-
Mathematics	6	6	6
Physics	2	2	2
Chemistry	2	2	2
Natural History	2	2	2
Physical Education	2	2	2

Note. Table originally in Arabic; translated from Student Handbook of Secondary Education (p. 27) by Ministry of Education, 1984, Manama, Bahrain: Author. Copyright 1984 by the Ministry of Education.

TABLE 6. Courses of Specialization

Divisions	Courses ^a	Grade 11 Periods/Week	Grade 12 Periods/Week
Mathematics	Mathematics	2	3
Physics	Physics	3	3
Chemistry	Chemistry	3	3
Natural History	Natural History	2	3

Note. Table originally in Arabic; translated from Student Handbook of Secondary Education (p. 27) by Ministry of Education, 1984, Manama, Bahrain: Author. Copyright 1984 by the Ministry of Education.

^aEach year students choose one of the following optional courses, taught three periods each week: typing, fine arts, French, technical drawing, automechanics, electronics, electricity, social studies, music, and home economics.

Reforms in Science Education

The reform in science education in the United States of America began with the development of PSSC physics. In 1956, a committee of university and secondary school physics teachers was formed to develop a new introductory course. This committee was called the Physical Science Study Committee (PSSC). In its first conference, the committee developed a general outline and listed points to be considered as themes of the course. These themes were:

1. The unity of physical science
Physical science, in interpreting the world around us, cannot be divided into many independent

fields because the phenomena it covers are interrelated.

2. Regularities

In discovering this interrelation, the observation of regularities in physical phenomena is necessary before laws covering the phenomena or models underlying them can be formulated.

3. Many independent arguments for one law

In establishing physical laws, many independent arguments should be used to help show the solidity with which the laws themselves are founded.

4. Deduction of phenomena from laws

From laws established to correlate one set of phenomena or more, we can deduce many other physical conclusions. We can make many deductions from the laws to show their power and scope. Even a simply physical law, such as the law of refraction, can be extended from a few cases to many more complex cases. Certain laws like the conservation of energy apply to a very large range of phenomena.

5. Limitations of physical laws

Physical laws are established over a range of phenomena and within a range of accuracy; thus established, they are not subject to further modification. True, the range over which a physical law is valid may extend to include new phenomena; but it must be emphasized that the range is usually limited.

6. Models

Models often provide a possible explanatory background for observed phenomena and suggest relations among them, which can then be investigated. When investigations reveal the limitations of laws or models previously established over a limited range, there may be established new physical laws and new phenomena. A new model thus replaces the old one but it must be stressed that it includes it. (Physical Science Study Committee [PSSC], 1957, p. 28)

The project was mainly supported financially by the National Science Foundation (NSF). Other funding agencies were The Ford Foundation and the Alfred P. Sloan Foundation. Several hundred people contributed to the

development of the course. Among those who played major roles in this process were professors Jerrold R. Zacharias and Francis Friedman, both from the Department of Physics at the Massachusetts Institute of Technology (MIT).

The course is "a considered answer to long standing feeling of dissatisfaction with present methods of teaching physics in the high school" (Tomer, 1958, p. 492). It was introduced in the fall of 1957 in eight schools whose physics teachers worked at MIT during the summer. In 1958, nearly 300 physics teachers attended summer institutes to study PSSC physics. A group of over 12,500 students and their teachers were used as a test group in the year 1958-59. The experience of this group was used as feedback to improve the course.

The development of the PSSC course was considered to be the beginning of a new era in science education. Many science curricula were developed after that. More than one-hundred-million dollars were spent by NSF on the development of new programs in science and mathematics in the 11 years following the production of PSSC physics. Thousands of people were involved in these projects, with person-hours perhaps in the millions (Welch, 1968, p. 225).

On the high school level, programs such as the Chemical Bond Approach (CBA), the Chemical Education

Material Study (CHEMS), and the Biological Science Curriculum Study (BSCS) were developed. On the elementary school level, projects such as the Elementary Science Study (ESS), the Science Curriculum Improvement Study (SCIS), and the American Association for the Advancement of Science (AAAS) programs appeared on the scene.

Lockard (1970) reports the ongoing development of 115 curriculum projects in the U.S.A. up to 1970. Welch (1979) presents some of the common characteristics of these programs:

1. Acronyms such as PSSC, CBA, BSCS, and ESS were used; therefore, the programs were known as the "alphabet curricula."
2. The programs represented the efforts of large groups of people including scientists, administrators, teachers, and educators.
3. The programs were written during summer conferences then tried out in large samples of schools mainly by experienced teachers.
4. The materials were disseminated through summer institutes that were held to familiarize teachers and administrators with the new programs.
5. Commercial publishers were selected for printing and marketing the projects.

6. The curriculum products emphasized how to "do" science. Methods of instruction that were referred to as inquiry, discovery, problem solving, and induction were employed. This fact is revealed in the introduction to the first edition of PSSC physics which states, "This textbook is the heart of the PSSC course, in which physics is presented not as a mere body of facts but basically as a continuing process by which men seek to understand the nature of the physical world" (PSSC, 1976, p. ii; as cited by Welch, 1979).

7. The programs were developed around conceptual schemes. For example, PSSC physics was structured around two basic themes which are the superposition principle that controls the wave action, the conservation laws of momentum and energy, as well as the dynamics of particles under the action of forces. The SCIS program was developed around the concept of changes that occur because of the interreaction of objects in reproducible ways under similar conditions.

In addition, the new programs emphasized the in-depth study of few concepts rather than an overview of the entire discipline. They also aimed at reducing study about the relationship of science to technology and aimed at concentrating on the understanding of science itself. In

the attempt to use the inquiry approach in studying science, laboratory work became an integral part of the course--providing opportunities to ask questions, tackle problems, and employ inquiry skills. There was also an emphasis on the tentative nature of scientific knowledge. A primary goal of the new programs was to equip students with the skills to update their knowledge (Dede & Hardin, 1973). Most new programs were accompanied by in-service programs to assist teachers in developing instructional skills and strategies appropriate to the particular program.

At the time when science education was undergoing reform in the United States, corresponding attempts were made in other parts of the world. Lockard (1970) reported 8 ongoing projects in Australia, 6 in Canada, and 20 in England--among these were 7 Nuffield projects.

Innovations in Science Education Outside the U.S.A.

The overview given here will primarily concern the Nuffield project. In 1962, the Nuffield Foundation carried out the activities of revising and updating the teaching of biology, chemistry, and physics in British grammar schools. "Traditions of syllabus, apparatus, and above all external examinations had tied teaching in

grammar schools to formal methods: mechanical problem-solving, cookbook laboratory work, and memorizing of much material for examination" (Rogers, 1967, p. 41).

To establish the physics course, a science inspector who acted as the organizer of the project selected a dozen teachers to act as advisors and they, in turn, became organizers of teams consisting of university physicists and practicing teachers. Each team underwent the process of stating aims, developing a section of the syllabus, and providing suggestions for the design of apparatus.

Rogers (1967) reported that it was "the intention of the Foundation that they were responding to needs for a renewal of the science curriculum, and for a wider study of imaginative ways of teaching scientific subjects."

Their goal was

to provide an integrated range of tested teaching resources in physics, chemistry and biology designed by teachers for teachers . . . equally suited for the future science specialists and for those who later specialize in other subjects or leave school at the age of 16. . . . [The central objective was to develop] science for all in the grammar-school group, not merely for the future specialist but for the future citizen in the latter half of the twentieth century. (pp. 40-41)

The central emphasis was that students would study science, gaining understanding through time and opportunities provided for them to learn, as they were engaged in problem-solving activities.

Successes and Failures of the Science
Curriculum Projects

Many studies have been done to assess and evaluate the impact of the various science projects (Douglas, 1973; Hurd, 1976; Lockard, 1970; Welch, 1968). Concerning the impact of PSSC, Douglas (1973) comments:

First came the physical science study committee (PSSC) course in high school physics. Up-to-date, rigorous emphasizing self-reliance on the part of the student, the course revolutionized physics teaching for a generation of scientists just now finishing their doctorates. In terms of speeding the process by which future physicists learned their trade, the course was a smashing success. As one Massachusetts Institute of Technology administrator put it, "We suddenly found ourselves boring the pants off our freshmen who had taken the course." (p. 187)

But while many young scientists were completing their PhDs, large numbers of students were avoiding physics altogether. In the 10 years after PSSC was introduced, enrollment in high school physics declined to the point that the percentage of students taking the course in 1970 was one-third less than the percentage in 1960. The importance of this decrease is disputed: Some educators have maintained that the decline was inevitable and resulted from many factors, but others have blamed the difficulty of PSSC for discouraging students:

At the same time, a scarcity of scientists changed into a seeming surplus in some fields . . . and the rationale of science education came under new scrutiny. "The course was just too traditional,"

Jerrold Zacharias, one of the original leaders of PSSC, says. "It was geared too much for people who might become physicists". . . . PSSC physics reached only about 20 percent of high school physics students during the sixties, according to Laurence Binda, head of the materials and instruction development section of the National Science Foundation. (Douglas, 1973, p. 187)

An impact study of the BSCS program was conducted by Hurd (1976). He differentiated between the terms impact and evaluation by defining the former as "a systematic report of the effects of a curriculum or instructional innovation" (p. 79). Hurd cited, as evidence of the impact upon enrollment, the number of articles published and research completed. In relation to enrollment pattern, Hurd reports:

We know for certain that previous to 1959 no student was studying BSCS biology. The experimental editions of the three BSCS textbooks (Blue, Green, Yellow) were tried out (1959-1963) in 950 high schools, involving 150,000 students and 1,000 teachers. . . . The 1961-62 revised experimental editions were used by 52,000 of the 1,686,318 students enrolled in biology for that school year. . . . The national enrollment in biology for the school year 1964-65 was 2,694,400 students. . . . Estimates of the number of students enrolled in BSCS courses vary from 328,000 . . . to 580,000. . . . [In the school year 1970-71] we can reasonably assume that 50% of the 2,729,306 . . . students taking high school biology . . . were in BSCS courses. (p. 80)

Hurd also assessed the enrollment impact of the BSCS course in terms of its stimulation of students to take biology courses. He found that "the percentage of students taking a course in biology rose from 23% in 1960-61 to 26%

of the total high school enrollment in Grades 9 through 12 in 1970-71" (p. 81). Hurd further cites as evidence of impact the improved ranking of biology in comparison to other high school subjects in terms of frequency of enrollment. During the decade from 1960 to 1970 the comparative ranking of biology increased from ninth to fifth.

In regard to published articles and research, Hurd reports:

There were eleven articles written about the BSCS biology project in 1959. From 1959 to 1975 a total of 1,029 articles on BSCS appeared in 135 different journals published in the U.S. and 88 articles on the subject were published in journals of foreign countries. . . . For the period 1960-75 . . . 301 investigations [have been conducted]. Of this number, 134 (44%) had as their major variable some aspect of the BSCS programs such as curriculum comparisons, instructional strategies, teacher behaviors, assessments of student learning, and special programs or audiovisual products. (p. 81)

The BSCS course also had an impact on the in-service preparation of teachers, with the National Science Foundation sponsoring programs to update the teachers. It seems that approximately 66% of the biology teachers in the United States have attended some type of NSF program for science educators.

Reporting on research by ERIC/SMEAC, Hurd states that this study found that science teachers attending NSF institutes are more likely to be using curriculum materials

developed with NSF support and lab activities, while stressing pupil-centered activities.

Although the impact of NSF programs on teacher behavior and attitudes has been the subject of more than 50 investigations . . . and over 500 studies on teacher behavior relating to science education . . . , we have very little information whether a specific innovative curriculum is being taught in the style envisaged by the authors. (Hurd, 1976, p. 83)

The impact of BSCS biology on pre-service education was moderate. Hurd adds that "one is led to conclude that neither the NSF-sponsored curricula nor its combinations of teacher training programs were sufficient to effect significant changes in the education of biology teachers--accountability movements notwithstanding" (p. 83).

It has also been noted that "follow-up studies of teachers who attended NSF-supported course implementation training programs indicated a 70 percent usage rate the year following the training, but about 70 percent of those new users dropped the program after the first year" (Boulanger, 1980, p. 73). However, teachers "who attended institutes exhibited an increase in continued graduate study, in professional activities, and in educational leadership roles" (Boulanger, 1980, p. 74).

Boulanger summarizes:

So was the national effort in curriculum reform a success? As with any multifaceted movement, the answer depends on the criteria applied. Many alternative programs with updated content

are available for school adoption; the number of scientists has increased dramatically; . . . and many teachers are better trained and more professional oriented. But the bottom-line measures of student enrollment in science, student interest in science, and finally student achievement in science reveal stability at best with general decline the more common observation. (1980, p. 74)

And, Welch (1979) adds that "although the problem that helped to generate the curriculum development activity has lessened, it seems unlikely that the reason is due to the success of the new curricula" (p. 299).

In the elementary school, the picture is not very bright. The National Science Teacher Association (NSTA) complains about the problem that science is often a neglected subject in the elementary grades (1983). The question was asked, "Why, in less than 10 years, have hands-on, activity-based programs faded almost entirely from the elementary school curriculum after so much time, effort and money were invested in developing and introducing them?" (Shymansky, Kyle, & Alport, 1982, p. 14).

The impact of the new curricula movement also may be measured in terms of the achievement of one of its major objectives--that is, developing inquiring children and adults. Welch, Klopfer, Aikenhead, and Robinson (1981) add:

For many years, the science education community has advocated the development of inquiry skills as an outcome of science instruction and for an equal number of years science educators have met with frustration and disappointment. In spite of new curricula, better trained teachers, and improved facilities and equipment, the optimistic expectations for students becoming inquirers have seldom been fulfilled. (p. 33)

Wilson and Koran (1976) attribute this situation partially to the fact that there is little agreement among science educators about the meaning of inquiry.

Herron (1977) attributes the unfavorable situation to the teachers. He comments:

We science educators speak glibly about children engaging in "rational inquiry" or the "inquiry approach" to science teaching. What we mean is that they are operating out of particular value system associated with science, and utilizing various science skills (observing, classifying, hypothesizing, and so forth) consistent with that value system. . . . Like most values, those characterizing the scientific endeavor are acquired primarily through the implicit curriculum rather than planned lesson. I maintain that the failure of the "new science" to teach the values lies in the fact that they are not held by large numbers of science teachers. (p. 30)

Welch et al. add that "there is evidence that inquiry training can result in significant changes in inquiry teaching methods" (1981, p. 37). They give reasons why some teachers who have had some form of inquiry-oriented training do not practice it in their teaching; these reasons are: that there are difficulties encountered in obtaining equipment and supplies; that inquiry can be

dangerous in classrooms where there are discipline problems; that inquiry does not work for most students (since it may cause confusion and is suitable for only very bright students); and that parents and teachers consider the main purpose of science instruction to be to prepare students for the next level of schooling and, that, hence, knowledge is valued more highly than inquiry skills (Welch et al., 1981, pp. 37, 38).

In-Service Education

This section will present some of the relevant literature in in-service education. According to Gall, Haisley, Baker, & Perez (1982, p. 2), "The intent of inservice education, more than any other aspect of human resource management, is to increase teacher effectiveness." Gall et al. (1982) also note that Bruce Joyce's definition of in-service education is the "formal and informal provision for the improvement of educators as people, educated persons and professionals, as well as in terms of the competence to carry out their assigned role." In addition, Voelker (1977) believes that "inservice education is the most important facet of science teacher education," which is so because "by its very nature, only parts of preservice education can be sufficiently relevant

to the actual work experience to have a major and continuing influence on science programs" (p. 70).

In-service education requires extensive efforts. However, research shows that in-service education has not been that effective (Gall et al., 1982). Horn (1976, p. 126) presents a summary of the weaknesses of the in-service programs as reported by other researchers:

1. They have restricted their focus to the remediation of teacher weaknesses, rather than capitalizing on current teacher strengths.
2. Their objectives have been irrelevant to the priority needs of teachers, students, and the community as each of these groups have perceived their needs.
3. No one has been held accountable for the success of in-service programs.
4. In-service instructors have had limited recent clinical experience.
5. Those who have initiated in-service programs have failed to cooperate with local universities and colleges in jointly planning the articulation of pre-service with in-service instruction.
6. In-service programs have not taken full advantage of modern communication media, thereby failing to reach a significant number of teachers.
7. In-service programs have failed to offer adequate incentives to the tenured teacher.

Voelker (1977) holds that "many approaches to inservice science teacher education are misdirected because they lack adequate conceptual framework for guidance" (p. 70).

King (1976) believes that administrators should put a high priority on in-service training; in fact, they should plan for this by including it in the academic calendar and

a follow-up supporting system should be established. Moreover, teachers also must be involved in the planning of these activities.

Horn (1976) presents a model for in-service training of science teachers in the United States:

Educational institutions and agencies would organize as a regional center. The center would function as the nerve center, for evaluation/research, instruction, curriculum development and as a resource bank for a given area. The service area for each center would best be defined by the natural and man-made barriers hindering accessibility. . . .

The director's job would be one of research and development as opposed to an administrative post. He/she would be responsible for:

1. initiating and conducting needs assessments
2. designing long-range plans for systematically addressing the determined needs
3. assisting participating districts in curriculum development
4. assisting individuals from the participating districts by providing career counseling
5. selecting and/or locally developing programs for addressing an identified need(s)
6. arranging for staff and facilities for activities in the center
7. continuously monitoring all aspects of the regional center's operation through process and product evaluation
8. developing a facility within the region that provides for a professional and curriculum library, workshop for materials and equipment development, media production, communications network, and professional consultation
9. developing and submitting proposals to local, state and federal agencies and private foundations for external support for regional inservice programs
10. administering the financial and personnel aspects of the center's operation. (pp. 141-142)

Ellis (1976) suggests that, in all probability, there is no one model of in-service training for science teachers which can satisfy all of the specific requirements for an individual school district. However,

the literature suggests that collaboration among the various interest groups in education will be required if viable, pertinent inservice science education programs are to be developed. Furthermore, inservice programs must be ongoing since society and the schools are rapidly changing.

Finally, science educators will have to focus their attention more intently on the assessment of the inservice programs for teachers of science. More work needs to be done in program evaluation. . . . We need to know what factors contribute to the successes and failures of the models we plan and implement. New relationships must be established between the schools, the colleges, and the teachers. The relationships must be of the type that will foster openness. The relationships must provide for meticulous assessment of the professional strengths and weaknesses of the inservice program participants. It does no good to establish inservice programs for science teachers that do not contribute substantially to the improvement of science instruction. We must do everything in our power to help science teachers to increase their knowledge, develop more positive attitudes and refine their skills. Only then can science educators be certain that science instruction will continually be improved. (p. 154)

Voelker (1977) believes that an effective in-service education for science teachers should have an adequate conceptual framework within which the concept of continuing education lies at the heart. The basic function of the in-service education of science teachers is, according to Voelker, to provide knowledge as well as to "develop skills

in making decisions and/or solving problems about learning science" (p. 61).

According to Voelker, further considerations of the function of in-service education are that:

1. A teacher must have a professional expectation to participate in inservice education, to work out continuously on all functions. It is necessary for the individual to develop a concept of his [or her] role in pursuing the attributes of the ideal teacher.
2. Inservice education should create a thirst for researched and tested approaches that make productive changes, innovations. The search should stem from a concept of continuous modification and evolution with research and development activity to give integrity to local decisions.
3. Science teachers should learn why and how to employ societal need as a persistent criterion for meeting science education goals.
4. Curriculum development is a major part of inservice science teacher education. Inservice should prepare teachers to answer the question, "What is your science curriculum?," by describing the dimensions rather than stating what materials they use. Teachers need to learn to develop a local curriculum framework in the image of the big goals of science education, as a basis for determining "goodness of fit." Curriculum work can help teachers to develop criteria for examining actions and evaluating materials and plans. Teachers need to become aware of innovations, develop techniques for examining and using innovations, and skills in implementing, institutionalizing, and maintaining sustained curriculum evolution.
5. Teachers need to learn concepts of instruction and instructional design. Skills are needed to recognize and diagnose learning difficulties; i.e., what do I need to know about science education, learners, schools, and myself to improve the learning process. We make enormous numbers of conscious and subconscious instructional decisions. A teacher must learn how to respond

- to and act on a system and yet to allow things to happen.
6. A critical part of inservice education is refining sensitivity to the learner's needs. This requires new and more knowledge about child development and learning, physiological development, the nature of the learning process--its differential and contextual character, and the nature of a person. This is more than knowing of motivation or Piagetian stages.
 7. Inservice programs must concentrate on teacher needs. Surface needs include "How do I use an aquarium to teach classification?" The real need is knowing what classification is.
 8. A concept of research and skill in conducting research and development is a critical element of inservice teacher education. But it cannot be developed until teachers recognize what decision-making is and what they are expected to do. There will be "action research" when teachers see themselves as decision-makers. (1977, pp. 62-63; emphases in original)

In addition, Voelker (1977) holds "that the key to inservice science teacher education is the individual teacher. His or her needs must be met in order for change to occur. Anything which detracts from responding directly to that individual's needs is potentially less effective" (p. 96).

Orlich (1984) outlines some components of an effective elementary in-service program:

- Effective inservice programs have a specific focus or set of objectives.
- Effective programs use curricula that can serve as exemplars.
- They provide hands-on experiences and allow teachers to use concrete teaching material.
- Laboratories, field trips, visits to museums, and opportunities to share experiences are part of the most effective programs.

- Effective inservice projects result from the ability of university faculty to adapt themselves to what is needed. Teachers do not automatically offer the usual courses.
- All effective inservice projects are relevant to the jobs of the participants and the conditions in which the participants actually work.
- A good program teaches participants how to use the knowledge they've gained, not simply how to gain it.
- The most effective inservice programs are apparently part of continuous programs, rather than just one-shot activities. (p. 35; emphases in original)

Hands-On, Process-Type Teacher Education

The first, basic rationale for providing a hands-on, process-type experience for science teachers is "that if an educational objective is to encourage elementary school teachers to teach science through inquiry, then preservice science instruction should be presented through the inquiry process" (Ginns & Foster, 1983, p. 277). The second rationale is the belief that such a type of training will lead to the development of positive attitudes toward science and science teaching by pre-service teachers:

It is thought that teachers who have positive attitudes toward science and science teaching will convey these attitudes to students in their classrooms and will be more likely to teach science to a greater extent than those teachers who have negative attitudes. (Sherwood & Gabel, 1980, p. 195)

Other outcomes of such training have been investigated, as demonstrated in the following paragraphs.

Kennedy (1973) was concerned about the fact that

throughout the nation, elementary school science at its worst, is ignored or simply not taught. . . . A number of new materials have been developed in the past ten years, to improve elementary school science: Science Curriculum Improvement Study, Elementary Science Study, Science--A Process Approach, etc. Their impact has best been described by J. Dudley Herron, who states: "These efforts have helped but none has been as potent in the real world as it was promising in the mind of the innovator who stood behind the idea." (p. 569)

Kennedy designed a study "to determine the effect of process approach instruction upon changing pre-service elementary teacher attitudes toward the concept of science and selected science processes." The results of the study showed that "the process approach applied to the science methods course for elementary teachers will change in a more positive direction, pre-service [teachers' attitudes] toward science and, hopefully, the teaching of science" (p. 573).

Riley (1975) investigated the effects of science process training on pre-service teachers' knowledge of process skills, understanding of science, attitude toward science, attitude toward science teaching, and attitude toward the inquiry strategy employed in the process training. He used two inquiry strategies with a group of 90 student teachers who were divided into three sections: the active-inquiry level, the vicarious-inquiry level, and

the control group. Both of the inquiry-level strategies incorporated the process approach of training. However, in the active-inquiry level, students used the hands-on manipulative approach, whereas those in the vicarious-inquiry level used the inquiring strategy without the manipulative skills.

The results indicate the efficacy of process training in terms of improved process skill abilities. . . . The study did not indicate any significant increase in the understanding of science nor any significant change in overall attitude toward science teaching as a result of training in process skills. (Riley, 1975, Abstract, n.p.)

Barufaldi, Huntsberger, and Lazarowitz (1976) conducted a study to explore changes in the attitudes of pre-service elementary education majors toward inquiry teaching strategies after they participated in a methods course designed to study the instructional methodology of a modern elementary science course. The instructional methodology incorporated the process approach to science teaching. The results of this study indicated that a more positive attitude toward inquiry strategies had been developed by the subjects after finishing the course (Barufaldi et al., 1976).

Brown (1977) studied the influence of process-skills instruction on the ability of pre-service teachers to demonstrate these skills in a paper-and-pencil situation.

Following a series of hands-on laboratory activities, performance was judged by a test specifically designed for the study. The results indicated that pre-service elementary teachers learned to use the process of science. Brown concludes that

If inservice teachers are to be held accountable for identifying and teaching a process component of science, then they should be provided with the skills necessary to execute this task. A way of attaining these skills is via the preservice mode. Preservice teachers can develop competency in the process component of science as defined by the activities used in this study. (p. 87)

Barufaldi and Bethel (1977) conducted research to "study the effect of a science methods course on the philosophical view of science among elementary education majors" (p. 289). After completing the study, the authors concluded that

it appears that a method course which stresses inquiry methods and procedures, emphasizing a hand-on approach integrated with individual problem solving, develops, alters, and enhances students' philosophical view of science. A science methods course of this nature is one vehicle by which effective and positive attitude changes in preservice teachers are developed toward the tentative nature of scientific knowledge. (p. 293)

Campbell (1979) conducted a study to investigate a theoretical assumption that "one of the advantages of teaching science process skills is due to their transfer effect to other academic curriculum areas." The results of his study showed that "preservice and inservice teachers'

reading comprehension can be significantly improved with process skills instruction" (p. 125).

Bluhm (1979) conducted a study to determine if pre-service teachers who received process skill instruction improved their ability to sequence science process skills as used in scientific problem-solving, as well as improve their knowledge and use of science process skills. Subjects received instruction involving instructor-guided, hands-on activities intended to teach science processes. The method of instruction was the independent variable and the dependent variable was achievement on a process-skills instrument specifically designed for the study. The results indicated that

preservice elementary school teachers, who are exposed to activity-based instruction in which they design and carry out an experiment to solve an observed problem, significantly improve their ability to sequence science process skills as used in scientific problem-solving. (p. 432)

Gabel and Rubba (1980) were concerned with the question: Where should process skills be taught? Their research was conducted to investigate whether any differences in the acquisition of process skills existed when such skills are taught as an integral part of a physics course as compared to when they were taught in isolation in a science methods course. Gabel and Rubba's research also investigated the differences in physics

students' attitudes toward science and science teaching when a course is tied to teaching science as compared to the attitudes of students in a methods course with similar experiences. The authors concluded that,

although care must be taken in interpreting the results because of teacher effects (only one physics professor and one science educator taught the courses), the data analysis seems to indicate that elementary education majors will make substantial gains in attitudes toward science teaching whether enrolled in a specially designed physics course or in a science methods course. (p. 125)

Sherwood and Gabel (1980) evaluated the outcome of a course for prospective elementary teachers that was introduced in the fall of 1978 at Indiana University. The designers of the course incorporated the elements from previous research that had been shown to be effective in the training of science teachers, that is: incorporating an inquiry orientation, using elementary science materials, adding a field component through relating the use of identical material, and employing an inquiry mode of instruction. Six instruments were used: Demographic Data Questionnaire, Fraction and Decimal Test, Basic Science Skills Test, Attitude Toward Science and Science Teaching, Mathematics Anxiety Test, and Content Achievement Test. The analysis of the results indicated that, in terms of the Basic Science Skills Test, "there was a significant pre-posttest difference in scores, as was expected. It was

disappointing that there weren't larger gains and that some items were so poorly answered" (p. 198). With reference to attitudes toward science and science teaching, the results "indicated that there were no significant differences between attitudes before or after the course" (p. 198).

The authors attribute the lack of change to many factors:

different instruments were used. . . . The mathematical part of the course (approximately one-third) was taught at the end of the semester right before the attitude posttest was given. The attitude scores may reflect students' attitude towards math more than their attitude toward science. (p. 200)

Since the attitude toward science remained positive, "it may be that a series of courses of this nature would be necessary to affect attitude changes" (p. 200).

Changing the attitudes of elementary science teachers toward science and science teaching seems to be the dominant theme in the research reviewed. In 1981, Morrissey wrote an article analyzing various studies conducted in regard to this subject. He gathered studies under the descriptors of elementary science-methods course studies, humanistic approaches, microteaching, audiotutorial and self-paced learning, inquiry approaches, inductive and deductive approaches, structured and unstructured approaches, process approaches, and practice teachings. Other studies concerned background-characteristics

studies, miscellaneous studies, and studies reported in abstracts.

Morrissey (1981) suggests that, based on results from various studies, teacher attitudes toward science and science teaching can be changed through methods courses.

However, the lack of change in the teaching of elementary science in the schools indicates that something more than just immediate attitude change must be considered. There is a need for a combination of: varying techniques to obtain attitude change toward science and science teaching in both pre-service and practicing elementary teachers; and a long range follow-up study to determine how effective and long lasting the recorded positive changes in attitudes are. A noticeable positive change in the actual teaching and learning of science in the elementary schools is the desired result of any research into elementary student teachers' attitudes toward science and science teaching. To obtain such a result, there is a need for research that will determine the factors that will yield positive changes in attitude and practice of elementary teachers toward science and science teaching. (p. 173)

In Australia, Ginns and Foster (1983) followed the previous suggestion. They took gender and the extent of previous science training into consideration when analyzing a study similar to the previous ones. The subjects were 471 students in the first year of a pre-service "Diploma in Teaching" course:

Students were . . . allocated randomly to two conditions. One group undertook a topic course. This approach involved the completion of topics or units of work in the physical, earth, and biological sciences. . . . The approach was wholly inquiry-based in an unstructured environment with students working in groups or on an individual basis. A second

group undertook a lecture course which involved a structured environment with whole-group lectures and related laboratory work. . . . Two measures were administered to each subject before and after the course. Understanding of Science was measured using the Test on Understanding Science (TOUS-Form W) . . . and attitudes by the Science Teacher Attitude Scales (STAS). . . . The effect of treatment group membership, sex, and science background on gain scores were assessed using three-way analysis of variance. . . . None of the main effects or interactions for understanding gain was significant. In the analysis of attitude changes, the two-way interaction, treatment by sex, was significant at the 0.05 level. . . . The interaction indicates that the male and female students responded differently to the two conditions. Males obtained higher positive gain scores for attitudes under the lecture approach, while females in this condition obtained the lowest of the four gain scores. In the topic approach, the females achieved a greater positive change in attitudes than the males. (Ginns & Foster, 1983, pp. 278, 280-281)

Voelker (1977) describes the result of the in-service education that was held for science teachers in the U.S. as a result of the innovations in science curricula. These resultant efforts were primarily those organized by governmental agencies such as the National Science Foundation (NSF) and most of the training sessions used a process approach form of training. Basically, in-service education appeared to be emphasizing academic performance growth which was especially directed at individual teacher needs. The results of these attempts were assessed by researchers to be the following:

1. Teachers did acquire more science background.
2. Institute participants continued graduate study and their mobility, especially upward, was enhanced by participation. Participants seemed to be more active professionally.
3. Attitudes toward institutes were positive but little evidence is available that attitudes toward science teaching were more positive.
4. Improvement, at least temporarily, in science teaching were identified as defined by institute organizers.
5. Better understanding of the nature of science was not necessarily transferred to improved science teaching or better attitudes toward science teaching.
6. Participants were primarily those who needed the least help. (Voelker, 1977, p. 65; emphasis in original)

Voelker documents that the various studies' findings on student growth were that:

1. Positive relationships (inferential) exist between institute participation and student achievement;
 2. Positive relationships between attitudes toward science and institute participation cannot be supported;
 3. There is a lack of experimental evidence that students of institute participants gained a better understanding of the nature of science.
- The potential outcomes of these forms appear to have been limited by heavy concentration on the academic growth function and external directive rather than response to teacher need. (p. 65)

In the NSF approach, the materials used were not developed by local teachers. "Much good came of this approach but the materials often were the mode for change rather than the process. The conditions for change may be lost by not participating in the total process" (Voelker, 1977, p. 65).

Voelker additionally discusses the subject of teacher involvement in producing materials; he describes the advantages and disadvantages as follows:

The approach has been an advance toward teacher involvement. A disadvantage was that the teachers involved in materials development, by comparison, may have needed less help. A strength is that teachers with ideas have improved materials. Another positive outcome of this materials form of inservice education is recognition that there is more to improving science teaching than "better" materials and more teacher science background. (Voelker, 1977, p. 65)

Highwood and Mertens (1972) reported an evaluation of the "Summer Institutes" that were held by the NSF:

[the] data indicate that the institutes have succeeded in upgrading the subject-matter competence of the participants. Coursework has been judged by the participants to be effective in increasing their understanding of and their ability to teach the concepts treated in the institute. Similarly, laboratory work was regarded as effective in increasing the participants' understanding of the concepts illustrated. Institute laboratory exercises were frequently adapted to the secondary-school classroom . . . the data [also] suggest that the institute program has been successful in changing the participants' philosophy of teaching. . . . [The institute's] program has provided stimulation for and advanced training leading to graduate degrees. (pp. 220-221)

Change Implementation

As previously mentioned, one of the characteristics of the reform movement in science education was to train teachers to teach these programs basically through summer institutes supported by the NSF (National Science

Foundation). Yet, in spite of these efforts, Welch (1979) reports that classroom instruction today does not differ much from the instruction 20 years ago, that the educational system is hard to change, and that changes in the curriculum account for very little of the variance in the learning of the students.

Fullan (1982) holds that the educational change is to a certain extent multidimensional. There are at least three components or dimensions at stake in implementing any new program or policy (1) the possible use of newer revised materials (direct instructional resources such as curriculum materials or technologies), (2) the possible use of new teaching approaches (i.e. new teaching strategies or activities), and (3) the possible alteration of beliefs (e.g. pedagogical assumptions and theories underlying particular new policies or programs). (p. 30, emphases in original)

He then gives some reasons as to why "the vast majority of curriculum development and other educational change 'adoptions' in the 1960s and 1970s did not become get in practice, even where implementation was desired" (p. 54) by stating that

Since the essence of educational change consists in learning new ways of thinking and doing, new skills, knowledge, attitudes, etc., it follows that staff development is one of the most important factors related to change in practice . . . [the] theme of training can be grossly misapplied unless it is understood in relation to the meaning of change and the change process taken as a whole. (Fullan, 1982, p. 66)

Fullan also summarizes that the reasons for the failure of most in-service education are, primarily, because:

1. One-shot workshops are widespread but are ineffective.
 2. Topics are frequently selected by people other than those for whom the in-service is intended.
 3. Follow-up support for ideas and practices introduced in in-service programs occurs in only a very small minority of cases.
 4. Follow-up evaluation occurs infrequently.
 5. In-service programs rarely address the individual needs and concerns. . . .
 6. The majority of programs involve teachers from many different schools and/or school districts, but there is no recognition of the differential impact of positive and negative factors within the systems to which they must return.
 7. There is a profound lack of any conceptual basis in the planning and implementing of in-service programs that would erase their effectiveness.
- (1982, p. 6)

One of the important pieces of work that shows how professional development can be incorporated in the change process is that of Joyce and Showers (1982). They hold that for a transfer of training to take place, one must incorporate the following components: theory, demonstrations, feedback, and application with coaching. The last element, which translates into on-site training, can handle the issue of transfer of training and prevent it from becoming a problem. In addition to coaching, there are three other techniques which may aid in solving the problem of transfer. In the words of Joyce and Showers (1982), these are:

1. Forecasting the transfer process throughout the training cycle
2. Reaching the highest possible level of skill development during training
3. Developing "executive control," that is, a "meta understanding" about how the models work, how it can be fitted into the instructional repertoire, and how it can be adapted to students. (p. 61)

The authors recommend creating a "coaching environment" in the school within which all of the personnel will view themselves as one another's coaches. But, in the present context, the primary function of coaching is to assist the acquisition of new teaching models.

The process of coaching involves five major functions; that is, the:

- Provision of companionship
- Giving of technical feedback
- Analysis of application: extending executive control
- Adaptation to students
- Personal facilitation. (Joyce & Showers, 1982, p. 6)

Fullan (1983) summarizes the main points that should be stressed for staff development and assistance during the implementation of any change in schools:

- (i) understand how the process of learning to implement an innovation actually works. . . . Remember that learning to be proficient at something new involves initial anxiety, a variety of assistance, small experiences of success, incremental skill development, and eventually conceptual clarity and ownership.
- (ii) invest selectively in front-end training--good demonstrations, materials, awareness, but not heavily into training (it is when people try

- out something that specific training makes most sense).
- (iii) invest as heavily as possible in assistance during the early stages (e.g., the first several months, or the first school year). Use a variety of formats--workshops, one-to-one, sharing among users, meetings, visits, help from peers, administrators, district resource staff. Both event training (workshops, meetings), and ongoing assistance (one-to-one sharing, interaction with others on a daily basis) are needed. Look for ways of finding small amounts of time to foster interaction whether formally or informally (see Huberman & Crandall, 1983; and Louis & Rosenblum, 1981).
 - (iv) clarify and provide training for assisters (where appropriate) concerning who does what at which stages among: external consultants, district office resource staff, the principal, project directors, school resource staff, peers. Different patterns can work provided that all phases of the process are attended to (front-end, early implementation, later implementation or institutionalization), and that there is clarity as to who is responsible for different functions. (p. 43; emphases in original)

Science Teachers' Competencies

Attempts were made within the literature review to identify the minimum basic teaching skills sought in science teachers. For example, in 1974 NSTA produced a list of 23 basic competencies sought to be developed in science teachers (Simpson & Brown, 1977). Based upon this research, Simpson and Brown conducted a study using the Delphi method to validate these competencies. Their panel of highly qualified educators in Georgia and Colorado were

asked to rank-order the competencies. The result was that 20 more items were added to the initial list of 23:

The investigators formulated that at least seven broad areas or "clusters" underlie all the items. This was accomplished by tabulating, then categorizing, each attribute or skill mentioned in the total 46-item list. They have been labeled as (1) knowledge of science, (2) professional knowledge and attitude, (3) human relations skills, (4) planning skills, (5) instructional skills, (6) management skills, and (7) evaluation skills. (Simpson & Brown, 1977, p. 217)

Butzow and Qureshi (1978) conducted a study to "identify observable competencies for prospective high school science teachers and attempt to validate the identified competencies" (p. 59). A total of 21 teachers were observed in the classroom; transcriptions were prepared from interviews, which were conducted using summarized observations and specific competency statements. The resulting 12 competencies were ranked into the following decreasing order:

1. A teacher must know his/her subject and keep striving to update his/her knowledge.
2. A teacher must have a good rapport with his/her students.
3. A teacher must recognize the individual academic abilities of his/her students and try to encourage each of these students.
4. A teacher must make his/her lessons interesting without wasting time.
5. A teacher must be able to control discipline problems in order to protect the learning experience of his/her students.
6. A teacher must plan class lessons in advance with the idea to present scientific concepts and ideas in an organized and clear manner.

7. A teacher must foster unbiased, independent and critical thinking in his/her students.
8. A teacher, especially the one who is teaching low or average ability students, must relate the scientific ideas he/she is teaching to the daily life experiences and the needs of the students.
9. A teacher must evaluate, in a traditional or any other practical sense, the academic progress of his/her students and make the results available to them as soon as possible.
10. A teacher must, appropriately, respond to the sudden diversions of students thoughts.
11. A teacher must take appropriate actions and instruct students about laboratory safety practices.
12. A teacher must fulfill his/her professional responsibilities. (p. 61)

Chiappetta and Collette (1978a) conducted a study in which they asked three stratified samples, each comprised of 100 science supervisors from across the country, to state, refine and rank-order competencies of secondary school science teachers. They developed a list of cognitive competencies. Rank-ordered, in descending sequence from 1 through 15, these competencies were (p. 70):

1. Formulates instruction that emphasizes the inquiry and process approach to teaching science.
2. Plans and organizes appropriate instruction.
3. Provides for individual differences.
4. Employs a variety of instructional strategies and techniques.
5. Evaluates student progress and success.

6. Demonstrates effective management of the science laboratory.

7. Interprets the psychology of learning as it relates to science instruction.

8. Organizes a relevant science curriculum.

9. Evaluates self as a teacher.

10. Emphasizes an interdisciplinary approach to science instruction.

11. Demonstrates written and oral fluency in the English language.

12. Works cooperatively with peers and administrators.

13. Judges the value of new and former science curricula.

14. Employs basic mathematics to science instruction.

15. Understands the history and philosophy of science.

In a second study, Chiappetta and Collette (1978b) gathered the perceptions of high school science teachers in order to determine the overall competencies considered necessary for secondary science teachers. Grouped into three random samples, 300 teachers participated in the study. The teachers generated competency statements and experts divided the responses into the three categories of (a) cognitive competencies, (b) affective competencies, and (c) personality characteristics (p. 74). In the

rank-ordering (p. 75), the following competencies were ranked 1 through 15:

1. Provides a humanly-supportive learning environment.
2. Integrates inquiry and science process into instruction.
3. Employs a variety of instructional techniques.
4. Implements the psychology of learning into instruction.
5. Utilizes an organized approach to teaching.
6. Organizes daily lesson plans.
7. Safely conducts productive laboratories.
8. Evaluates students' progress.
9. Associates science with "what goes on in the world."
10. Evidences a general education background in teaching.
11. Judges the effectiveness of classroom communication.
12. Judges the effectiveness of classroom discipline.
13. Organizes one's background in science.
14. Evaluates one's professional growth.
15. Judges one's professionalism.

Needs Assessment Instruments

Several attempts have been made to develop instruments for assessing the professional needs of science teachers. Moore (1977) reports on four of these instruments (including ones developed by Horrocks, Piltz, Savage, and the National Science Teacher Association). Moore holds that such instruments are limited because they are only applicable to elementary school teachers and they cannot be used to assess the needs of science teachers in all disciplines. Moore (1977) describes his instrument, the Moore Assessment Profile (MAP), as consisting of 117 science teacher need statements. The need statements are subdivided into six general areas: Area One contains 17 items related to the development of a better understanding of students; Area Two consists of 10 items related to the betterment of diagnosis and evaluation practices; Area Three includes 11 items related to the development of better classroom management practices; Area Four has 31 items related to the improvement of classroom instruction and planning; Area Five includes 18 items related to the more effective use of instructional materials; and Area Six contains 30 items related to the self-improvement of the classroom science teacher (Moore, 1977, p. 146).

Zurub and Rubba (1983) reported the development and validation of a needs assessment instrument that could be used in developing nations such as the Arab countries. This instrument has been termed the Science Teacher Inventory of Need (STIN) and consists of 76 inventory items and 7 open-ended items. STIN was translated into Arabic and used with 555 upper-secondary level Jordanian science teachers.

The research conducted by Zurub (1982), using STIN, indicated that some general needs were perceived by Jordanian secondary-level science teachers, whereas other needs were more specific to subgroups of these science teachers. Regarding the needs of science teachers, the researcher stated the conclusions as follows:

The most intense perceived needs of the Jordanian secondary level science teachers who were in the sample were in the areas of: (1) organizing a science laboratory room; (2) updating one's knowledge of man's utilization of science/technology; (3) working towards a degree in science education; (4) providing for students' safety in the laboratory; (5) motivating students to learn science; (6) maintaining science laboratory equipment; (7) selecting supportive materials (library books, films) for science instruction; (8) identifying sources of free and inexpensive science instructional materials; (9) using audio-visual equipment to support science instruction; (10) selecting science laboratory equipment for student use; (11) updating one's background in curriculum development; (12) maintaining live organisms for science instruction; . . . (14) using area/regional resources to support science instruction; (15) updating one's knowledge of science-related career opportunities for students;

(16) communicating student science learning progress to the student, administrators and parents;
(17) constructing science laboratory equipment;
(18) updating one's scientific knowledge in chemistry;
(19) arranging the physical environment for science instruction; and (20) establishing a science curriculum/program. (Zurub, 1982, pp. 104-105)

Another study regarding the needs of science teachers was conducted in Kuwait by Hashem (1982). The purpose of this study was to assess the professional needs of secondary-level biology teachers in Kuwait so as to determine the effectiveness of in-service programs. The following conclusions were made:

1. The population of the study lacked in academic background preparation, both in terms of quality and quantity of biology and teaching methods course.
2. A majority of the respondents reported that they had not received high quality in-service training since they had commenced their teaching careers.
3. The most desirable in-service topics reported by the population were Curriculum Development and Methods and Techniques of Instruction.
4. The majority of the population employed whole classes as their sole method of instruction. (Hashem, 1982, Abstract, n.p.)

Summary

Reforms in science education began in the United States of America in 1956, with the development of PSSC physics. Other secondary- and elementary-level curricula were subsequently introduced. These programs all emphasized the process of science.

In general, the results of the curriculum reform were that: many updated programs were available for school adoption; and the numbers of scientists and well-trained teachers increased; but, the main goals of increasing student enrollment in science, developing student interest in science, improving achievement in science, and students becoming inquirers have not been achieved. On the elementary-school level, the new programs have almost faded away.

Researchers concur that staff development is an important aspect of science teacher education and that it must have a higher priority. Some efforts of in-service education have been weakened by such factors as failing to address the needs of teachers, students, and communities. Aspects of staff development identified as leading to successful in-service programs include: basing the programs upon the idea of continuing education, concentrating on teachers' needs, using concrete materials, and helping the teachers implement the knowledge they gain.

Staff development has been seen as one of the most important factors in change implementation. For transfer of training to take place, the following elements of training must be considered: theory, demonstration, feedback, and application with coaching.

In science, efforts have been made to identify the minimum basic teaching skills (or competencies) sought in science teachers and to develop instruments to measure these skills. NSTA (the National Science Teacher Association) has developed one list of competencies, Chiappetta and Collette have developed two lists of competencies, and Butzow and Qureshi one list. Among the instruments developed have been the Moore Assessment Profile (MAP) and the Science Teacher Inventory of Need (STIN).

CHAPTER III

METHODOLOGY OF THE STUDY

Design

The purpose of this study was to investigate perceptions of professional competencies of the science teachers in the secondary schools in Bahrain and to relate these competencies to the new science curriculum. The competencies were investigated in relationship to: variables of years of experience, subject matter taught, and the nature of preparation and qualification.

The research questions were:

1. What professional competencies of science instruction are most frequently identified as being of moderate or great need by secondary science teachers in Bahrain?

2. What professional competencies of science instruction are most frequently identified as being of moderate or great importance to the teaching of the new science curriculum by secondary science teachers in Bahrain?

3. Which categories of the competencies are perceived as being of greatest need, and which are perceived as being of greatest importance?

4. Is the perception of professional competencies of science instruction by secondary science teachers in Bahrain related to teaching experience, nature of preparation and qualification, and subject area taught?

This research employed a descriptive design. The overall purpose was to examine the relationships among perception of importance and need of identified science teaching competencies and personal and institutional factors such as subject area taught, teaching experience, and nature of preparation and qualification. The data collection employed the use of a questionnaire.

Instrumentation

The instrument, a questionnaire which assessed the needs of science teachers in relationship to particular teaching behaviors and the perceived importance of these behaviors, was adapted from the Science Teacher Instrument of Need (STIN) developed by Zurub (1982). Additional items were adopted from the National Science Teacher Association's (NSTA's) list of competencies (as reported by Simpson and Brown, 1977). Other items were taken from

Zoller and Watson (1974) and Chiappetta and Collette (1978a). Table 7 presents the competencies of science teaching and the sources of their identification. Cross-referenced to each competency are the two instruments (STIN and MAP--the Moore Assessment Profile, Moore, 1977) and the four lists of competencies (NSTA, as cited by Simpson & Brown, 1977; Chiappetta & Collette, 1978a, referred to as "C-a"; Chiappetta & Collette, 1978b, referred to as "C-b"; and Butzow & Qureshi, 1978, referred to as "B").

A tentative form of this instrument was reviewed, for content validation, by 12 judges who were experts in science education: 5 of these judges were University professors in science education, 6 were graduate students in the College of Education at the University of Oregon, and the 12th person was an Arab woman who taught physics for a number of years in Jordan and who had a doctorate in science education.

The questionnaire contained 87 items. For each item, the judges were asked to indicate if they thought that the item represented an appropriate competency for science teachers by circling yes or no. If they believed that an item represented an appropriate competency but was not stated correctly, they were asked to rewrite the competency in an alternative form. In addition, they were asked if

TABLE 7. Competencies Identified by Author and/or Instrument Source

Competency	Source of Identification					
	MAP	SIIN	NSIA	C-a	C-b	B
1. Determining pupil readiness for learning.	X	X				
2. Understanding the behavior of students who have learning difficulties.	X	X				
3. Motivating the student.	X	X				
4. Understanding the educational goals set up by the student, family and society.	X					
5. Understanding the different dialects of students.	X					
6. Understanding the influence of the family and community on student learning.	X					
7. Students evaluating themselves.	X					
8. Reporting effectively the progress of students.	X	X				
9. Utilizing information to determine needs.	X	X				
10. Organizing physical environment.	X	X				
11. Employing grouping.	X	X				
12. Establishing and maintaining discipline.	X	X				
13. Receiving guidance and assistance.	X			X		
14. Guiding students.	X					
15. Organizing resources and materials.	X					
16. Presenting science according to grade levels.	X					
17. Making science meaningful.	X					
18. Demonstrating principles.	X					
19. Determining what to teach.	X	X				
20. Developing in students some desirable traits, such as critical thinking.	X	X				
21. Developing techniques for teaching science in an overcrowded condition.	X					X
22. Using supplementary science books.	X					
23. Effective utilization of library.	X					
24. Effective use of educational technology.	X	X				
25. Preparing a variety of instructional material.	X	X				
26. Obtaining a variety of materials, living things, help and advice.	X	X				
27. Supervising paraprofessionals.	X	X				
28. Effective use of instructional material.	X	X				
29. Integrating science into the curriculum.	X					
30. Updating one's knowledge in supporting fields.	X					
31. Updating one's knowledge in science.	X					
32. Updating one's knowledge in laboratory techniques.	X					

Note. MAP = Moore Assessment Profile (Moore, 1977); SIIN = Science Teacher Instrument of Need (Zurub, 1982); NSIA = National Science Teacher Association (Simpson & Brown, 1977); C-b = Chiappetta & Collette (1978b); C-a = Chiappetta & Collette (1978a); B = Butzow & Qureshi (1978).

TABLE 7--Continued

Competency	Source of Identification				
	MAP	SIIN	NSIA	C-a	C-b B
33. Employing individualized instructors.	X	X		X	
34. Employing team teaching.	X	X			
35. Confidence in carrying out science-related activities.	X	X			
36. Establishing humane learning environment.	X	X			X
37. Rationalizing the teaching of science.					
38. Arranging instructional objectives.					
39. Constructing and using item bank.					
40. Using oral questions.					
41. Administering tests.					
42. Developing lesson plans.					
43. Delivering a lecture.					
44. Employing simulation techniques.					
45. Employing team teaching.					
46. Employing value clarification techniques.					
47. Conducting panels.					
48. Employing peer tutoring.					
49. Using computers for managing instruction.					
50. Organizing the laboratory room.					
51. Setting up laboratory supply order.					
52. Updating one's knowledge of man's utilization of science technology.					
53. Updating one's knowledge of science-related careers.					
54. Updating one's knowledge in issues related to science and society.					
55. Evaluating classroom behavior.	X	X		X	X
56. Commitment to science teaching.					
57. Designing a variety of assignments.					
58. Designing, preparing, and directing laboratory operations.	X	X		X	
59. Evaluating student achievement by many means and assigning grades.	X	X		X	X
60. Possessing a repertoire of teaching needs.	X	X		X	X
61. Developing realistic lesson plans for several sciences.					
62. Defining and discussing science process and values.					
63. Developing exams composed of a variety of questions.					
64. Encouraging students to do projects.					
65. Stating objectives of units of science.					

Note. MAP = Moore Assessment Profile (Moore, 1977); SIIN = Science Teacher Instrument of Need (Zurub, 1982); NSIA = National Science Teacher Association (Simpson & Brown, 1977); C-b = Chiappetta & Collette (1978a); C-a = Chiappetta & Collette (1978b); B = Butzow & Qureshi (1978).

TABLE 7--Continued

Competency	Source of Identification				
	MAP	SIIN	NSIA	C-a	C-b B
66. Becoming aware of laws and measures of safety in science teaching.	X	X	X	X	X
67. Selecting, evaluating and using audiovisual materials.	X	X	X		
68. Becoming acquainted with the new science curricula.			X		
69. Locating and using areas for field trips.	X	X	X		
70. Becoming aware and capable of coping with many forces affecting concept formation.	X		X		
71. Competency in demonstrations.			X		
72. Active participation in improving science teaching.			X		
73. Storing and maintaining science material and equipment.	X	X	X		
74. Dealing with controversial issues.			X		
75. Locating supplementary materials.	X	X	X		
76. Preparing budget.	X	X	X		
77. Identifying and completing actions related to clubs, fairs, etc.			X		
78. Good rapport with students.					X
79. Making interesting lessons with wasting time.					X
80. Responding to sudden diversions of student thought.					X
81. Relating the scientific ideas to the daily life experience and needs of students.					X
82. Recognizing the individual ability of each student and providing encouragement.					X
83. Planning the lesson in advance.					X
84. Fulfilling their professional responsibilities.					X
85. Employing the psychology of learning.				X	X
86. Utilizing an organized approach to teaching.				X	X
87. Providing evidence of general education background.				X	X
88. Relating science with events.				X	X
89. Judging the effectiveness of the communication done in the classroom.				X	X
90. Judging one's professionalism.				X	X
91. Planning and organizing appropriate instructions.			X		
92. Organizing a relevant science curricula.			X		
93. Emphasizing interdisciplinary approach.			X		
94. Demonstrating fluency in English.			X		
95. Working cooperatively with colleagues.			X		
96. Judging the value of new and former curricula.			X		
97. Employing mathematics.			X		
98. Understanding philosophy and history of science.			X		

Note. MAP = Moore Assessment Profile (Moore, 1977); SIIN = Science Teacher Instrument of Need (Zurub, 1982); NSIA = National Science Teacher Association (Simpson & Brown, 1977); C-b = Chiappetta & Collette (1978a); C-a = Chiappetta & Collette (1978b); B = Butzow & Qureshi (1978).

there were competencies not covered in the instrument that should be included. Based on the responses of the judges, a revised form of the instrument was constructed and titled the Needs Assessment of Science Teachers (NAST). The final form of the questionnaire was translated into Arabic; two Arabic graduate students studying physics at the University of Oregon helped to validate this translation. The Arabic version of the NAST was distributed to all of the science teachers in secondary schools in Bahrain through the Ministry of Education.

The questionnaire consisted of four parts. The first part was a letter addressed to the science teachers which described the purpose of the study and requested their cooperation in responding to the study. The letter also informed the teachers that the data of the study would be confidential and asked if they would like a copy of the results of the study. The second part was designed to provide necessary demographic information such as gender, total number of years of teaching experience, and the nature of preparation and qualification. The third part provided instructions for completion of the questionnaire with illustrative examples. The fourth part consisted of the questionnaire itself. It is composed of 74 items and

is divided into seven categories; 7 of the items were open-ended questions.

The first of the seven categories addresses the specific objectives for science instruction; the first category contains 5 items, 1 of which is open-ended. The second category concerns diagnosing and evaluating learners for science instruction; it contains 8 items, 1 of which is open-ended. The third category concerns planning science instruction; it contains 6 items, 1 of which is open-ended. The fourth category concerns delivering science instruction; it contains 22 categories, 1 of which is open-ended. Managing science instruction is the fifth category and contains 11 items, 1 of which is open-ended. The sixth category is administering science instructional facilities and equipment; it contains 9 items, 1 of which is open-ended. The last category concerns science teacher self-improvement; it contains 13 items, 1 of which is open-ended (see Table 8).

The instrument has two scales, importance and need. The first scale addresses the importance of items as related to teaching the new science curriculum. This scale is coded into four levels: this activity is not important (1); this activity is of little importance (2); this

activity is moderately important (3); and this activity is of great importance (4).

TABLE 8. Number of Items in Each
Category of the Instrument

Category	Number of Items
A. Specifying Objectives for Science Instruction	5
B. Diagnosing and Evaluating Learners for Science Instruction	8
C. Planning Science Instruction	6
D. Delivering Science Instruction	22
E. Managing Science Instruction	11
F. Administering Science Instructional Facilities and Equipment	9
G. Science Teacher Self-Improvement	13

The second scale addresses the perceived need of assistance to become competent in the particular activity described by each statement. Such assistance may be provided through in-service training, personal help, or further education. The codes for this scale are: I have no need for assistance (5); I have little need for assistance (6); I have moderate need for assistance (7); and I have a great need for assistance (8).

The respondents were directed to respond to both scales by circling one response, within each scale, for each item.

The reliability of the instrument was calculated for each category using Cronbach's Alpha. The values ranged from 0.537 to 0.951 (see Table 9). The reliability coefficient of the combined categories for importance is 0.955. The number of people who responded to all of the items on importance was 29. The reliability coefficient of the combined categories for need is 0.980. The number of subjects who responded to all of the items on need was 24.

Subjects

The subjects who participated in the study were all of the secondary school science teachers in Bahrain during the academic year 1984-85.

There are 14 secondary schools in Bahrain: 8 schools are girls' schools and 6 are boys' schools. Of the girls' schools, 5 are located on the main island, Bahrain; the other 3 girls' schools are located on the second-largest island, Muharrag. Of the boys' schools, 4 are located on the island of Bahrain and 1 is located in Muharrag (see Table 10).

TABLE 9. Values of Reliability Coefficient Alphas for Each Category and the Number of Subjects Who Responded to All of the Items in Each Category

Category	Number of Items	Cronbach's Alpha		Number of Cases	
		Importance	Need	Importance	Need
A. Specific Objectives for Science Instruction	4	0.696	0.837	77	73
B. Diagnosing and Evaluating Learners for Science Instruction	7	0.569	0.834	74	72
C. Planning Science Instruction	5	0.536	0.848	61	50
D. Delivering Science Instruction	21	0.847	0.950	62	55
E. Managing Science Instruction	10	0.730	0.880	65	54
F. Administering Science Instructional Facilities and Equipment	8	0.803	0.908	68	61
G. Science Teacher Self-Improvement	12	0.846	0.927	73	62
Combined Categories	67	0.995	0.980	29	24

TABLE 10. Number of Students and Classrooms in General Secondary Education by Administrative Area and Gender for Scholastic Year 1983-84

Area	Number of Classrooms			Number of Students		
	Female	Male	Total	Female	Male	Total
Hidd	7	0	7	212	0	212
Muharraaq	23	18	41	655	472	1,127
Manama	32	34	66	1,013	996	2,009
Jiddhafs	16	0	16	578	0	578
Northern	0	0	0	0	0	0
Sitra	0	0	0	0	0	0
Central	0	0	0	0	0	0
Isa Town	17	10	27	544	305	849
Riffa	14	14	28	429	415	844
Western	0	0	0	0	0	0
Total	109	76	185	3,431	2,188	5,619

Note. Table originally in Arabic; translated from Educational Statistics for the Years 1983-84 (p. 115) by Ministry of Education Statistics Section, 1984, Manama, Bahrain: Author. Copyright 1984 by Ministry of Education Statistics Section.

There were 98 teachers identified as secondary science teachers; all were asked to participate in the study. A total of 93 teachers responded to the questionnaire, yielding a response rate of 94.9%.

The teachers varied in their number of years of teaching experience--from a low of 1 year to a high of 23 years (see Table 11). The mean was 8.68 years, with a standard deviation of 5.63.

TABLE 11. Number of Years of Experience of the Teachers

Years of Experience	Frequency	Percentage
1	2	2.2
2	9	9.7
3	6	6.5
4	8	8.6
5	5	5.4
6	8	8.6
7	8	8.6
8	1	1.1
9	6	6.5
10	5	5.4
11	2	2.2
12	2	2.2
13	3	3.2
14	2	2.2
15	9	9.7
16	2	2.2
17	1	1.1
18	2	2.2
19	1	1.1
20	1	1.1
21	1	1.1
22	1	1.1
23	1	1.1
Missing	7	7.5

The number of years of experience in teaching science also ranged from 1 to 23 (see Table 12), with a mean of 8.79 and standard deviation of 5.64.

TABLE 12. Number of Years of Experience in Teaching Science

Years of Experience in Teaching Science	Frequency	Percentage
1	3	3.2
2	7	7.5
3	7	7.5
4	9	9.7
5	5	5.4
6	7	7.5
7	7	7.5
8	1	1.1
9	7	7.5
10	5	5.4
11	2	2.2
12	2	2.2
13	3	3.2
14	2	2.2
15	9	9.7
16	3	3.2
17	1	1.1
18	2	2.2
19	1	1.1
20	1	1.1
21	1	1.1
22	1	1.1
23	1	1.1
Missing	6	6.5

The number of periods that the teachers taught per week ranged from 6 to 22 (see Table 13). The mean was 16.87 and the standard deviation was 3.45.

TABLE 13. Number of Periods Taught Per Week

Number of Periods Taught Per Week	Frequency	Percentage
6	1	1.1
7	2	2.2
8	0	0.0
9	3	3.2
10	3	3.2
11	1	1.1
12	1	1.1
13	0	0.0
14	1	1.1
15	7	7.5
16	10	10.8
17	6	6.5
18	23	24.7
19	11	11.8
20	15	16.1
21	2	2.2
22	1	1.1
Missing	6	6.5

The number of periods of teaching science per week also varied from 6 to 22 (see Table 14). The mean was 16.27 and the standard deviation was 3.07.

The highest degrees held by the teachers are presented in Table 15; Table 16 presents their academic majors.

There were 9 teachers who reported having other qualifications besides their science degree: 6 had education degrees, 1 had a degree in computers, 1 a degree in electronics, and 1 a degree in accounting and chemical safety. When asked if they held a teaching diploma, the

majority (58.1%) responded in the negative (see Table 17). There was only 1 teacher currently working toward a degree in science or science education.

TABLE 14. Number of Periods Per Week
of Teaching Science

Number of Periods of Teaching Science	Frequency	Percentage
6	1	1.1
7	0	0.0
8	0	0.0
9	3	3.2
10	4	4.3
11	1	1.1
12	2	2.2
13	0	0.0
14	1	1.1
15	13	14.0
16	16	17.2
17	13	14.0
18	15	16.1
19	5	5.4
20	8	8.6
21	2	2.2
22	1	1.1
Missing	8	8.6

TABLE 15. Highest Degrees Received by Teachers

Highest Degree Received	Frequency	Percentage
Teacher-Training College Degree	4	4.30
Bachelor's Degree	88	94.62
Missing	1	1.10

TABLE 16. Academic Majors of the Teachers

Major	Frequency	Percentage
Biology	15	16.1
Chemistry	18	19.3
Physics	9	9.7
Biology and Chemistry	21	22.6
Chemistry and Physics	19	20.9
General Science	4	4.3
Geology	2	2.1
Missing	5	5.4

TABLE 17. Number of Teachers With Teaching Diplomas

Teaching Diploma?	Frequency	Percentage
Yes	32	34.4
No	54	58.1
Missing	7	7.5

The teachers were divided into subgroups according to the subjects they taught. Those who taught more than one subject were classified according to the subject in which they had the most time allotted (biology, chemistry, or physics). Teachers who had a number of periods or total

assignment of teaching subjects other than biology, chemistry, or physics were classified as "others." Some of the teachers had an equal number of periods of teaching two or three subjects and were classified as "mixed assignment" (see Table 18). The number of subject areas taught by the teachers ranged from one to four (see Table 19).

TABLE 18. Subject Areas Taught by Teachers

Subject Taught	Frequency	Percentage
Biology	20	21.5
Chemistry	19	20.4
Physics	26	27.9
Other	9	9.7
Mixed Assignment	13	13.9
Missing	6	6.4

TABLE 19. Number of Subject Areas Taught

Number of Subjects	Frequency	Percentage
1	35	32.6
2	33	30.7
3	16	14.9
4	2	1.9
Missing	6	5.6

The number of teachers within biology, chemistry, and physics categories are reported in Tables 20, 21, and 22.

Teachers who taught equally two or three subjects included: 4 who taught chemistry and physics; 2 biology and chemistry; 2 biology and general science; 1 biology and geology; 1 biology, chemistry, geology, and physics; 1 biology, chemistry, and geology; 1 chemistry, physics, and general science; and 1 biology, chemistry, and other subjects. There were 9 teachers who mainly taught subjects other than physics, chemistry, geology, or biology: 5 of these taught only general science; 2 chemistry and general science; 1 chemistry, physics, and general science; and 1 general science, biology, and chemistry.

TABLE 20. Number of Teachers Teaching Biology
With or Without Other Subjects

Subject(s)	Number of Teachers
Biology	9
Biology/Chemistry	3
Biology/Geology	3
Biology/General Science	2
Biology/Chemistry/Home Economics	1
Biology/Chemistry/Geology	1
Biology/Geology/General Science	1
Total	20

TABLE 21. Number of Teachers Teaching Chemistry
With or Without Other Subjects

Subject(s)	Number of Teachers
Chemistry	10
Chemistry/Biology	1
Chemistry/Physics	2
Chemistry/Physics/General Science	2
Chemistry/General Science/Computers	1
Chemistry/Biology/Geology/Physics	1
Chemistry/Biology/General Science	2
Total	19

TABLE 22. Number of Teachers Teaching Physics
With or Without Other Subjects

Subject(s)	Number of Teachers
Physics	11
Physics/Biology	1
Physics/Chemistry	8
Physics/General Science	2
Physics/Chemistry/General Science	2
Physics/Chemistry/Biology	1
Physics/Biology/General Science	1
Total	26

Collection of Data

In January 1985 a letter was sent to the Director of the Curriculum in the Ministry of Education in Bahrain, informing him of the study and requesting his assistance. A phone call was also made to the Director seeking his help. On May 1, 1985, a letter was sent to the Assistant Director of Curriculum and Training (Appendix A) with the questionnaires which were to be sent to the teachers.

The questionnaire was sent to the 14 secondary schools in Bahrain with a letter from the Head Supervisor of Science Teachers informing the teachers about the questionnaire (Appendix B). The responses of the teachers were sent back to the Ministry of Education and mailed to the author.

Treatment of the Data

The collected data were used to provide answers to the study's research questions.

To answer Research Question 1, a frequency table for each item was prepared by calculating the number of respondents who reported moderate or great need. The items were then rank-ordered according to those which had the highest frequency.

A similar method was used for Research Question 2. A frequency table was prepared for each item by calculating

the number of respondents who reported moderate or great importance. The items were then rank-ordered according to the frequency.

To answer Research Question 3, the mean of the means of each category was calculated and the highest mean among categories was taken as an indication that the category was perceived as that of greatest need.

Research Question 4 was answered by conducting an analysis of variance for each of the following:

1. Subject area taught versus importance.
2. Subjects taught versus need for assistance.
3. Teaching experience versus importance.
4. Teaching experience versus need of assistance.
5. Teaching experience in teaching science versus importance.
6. Teaching experience in teaching science versus need of assistance.
7. Nature of preparation versus importance.
8. Nature of preparation versus need of assistance.
9. Qualification versus importance.
10. Qualification versus need of assistance.

Tukey's Honestly Significant Difference (HSD) Test was used to analyze the analysis of variance tests which showed significant values.

CHAPTER IV

RESULTS AND DISCUSSION OF DATA

The collected data are reported and analyzed in this chapter. Although the questionnaire contained 74 items, the quantitative data analysis was restricted to those items which were amenable to numerical results; that is, excluding the open-ended items (numbered 5, 13, 19, 41, 52, 61, and 74). The results are organized according to the study's four research questions.

Research Question 1: Need for Competency

The question "What professional competencies of science instruction are most frequently identified as being of moderate or great need by secondary science teachers in Bahrain?" was answered by calculating, for each item, the number of people who reported moderate or great need for assistance in becoming competent in the particular activity described. The items were ranked in order according to the frequency of such responses--as shown in Table 23.

TABLE 23. Rank of Need for Each Item by Category, Item Number, and Frequency

Rank	Category	Item Number and Item	Frequency
1.0	G	62. Update one's scientific knowledge in the field of teaching.	68
2.0	G	64. Update one's scientific laboratory skills in the field of teaching.	67
3.5	G	66. Update one's knowledge of the way people utilize science/technology.	66
3.5	G	67. Update one's knowledge of science-related career opportunities for students and make these available for students.	66
5.5	G	63. Incorporate the new knowledge appropriately into curriculum being taught.	65
5.5	G	72. Become a professionally-active participant in the improvement of science teaching (e.g., experienced teachers provide help and guidance for the beginning teachers; organize workshops, seminars, etc.).	65
8.0	F	57. Select and evaluate science laboratory equipment for student use, based on stated criteria.	63
8.0	G	68. Update one's knowledge of science-related societal issues.	63
8.0	G	73. Become acquainted with the major new science programs from other countries and the way(s) in which such programs might affect the science curriculum in Bahrain.	63
10.0	F	56. Design and construct simple science laboratory equipment.	62
11.0	D	36. Use computers/teaching machines to support science instruction.	59
12.0	G	69. Update one's background in theories of cognitive and affective development, learning, and instruction.	58
13.0	G	65. Adapt suitable new methods of scientific laboratory skills for the classroom.	56
14.5	D	21. Encourage students to undertake projects, and be willing to assist and advise their efforts.	55
14.5	F	60. Maintain live organisms for science instruction.	55
16.5	F	55. Maintain science laboratory equipment.	54
16.5	G	71. Update one's background in the philosophy of science.	54
18.0	F	58. Identify sources of free and inexpensive science instructional materials.	53
21.0	D	35. Use a variety of audiovisual equipment to support science instruction.	52
21.0	E	42. Manage a science instructional budget.	52
21.0	F	53. Assist in the setting up of a laboratory supply order, storage and retrieval system.	52
21.0	F	54. Organize a science laboratory room.	52
21.0	F	59. Select and evaluate supportive materials (library books, films) for science instruction, based on stated criteria.	52

Note. Dashed line indicates the separation between the first third and second third of the highest-ranked items.

TABLE 23--Continued

Rank	Category	Item Number and Item	Frequency
25.0	E	47. Supervise a paraprofessional in the science classroom/laboratory (e.g., laboratory technician).	51
25.0	E	51. Use a computer to manage maintain student records, create resource files, write and store assessment items, maintain inventories, and prepare grade and progress reports, etc.	51
25.0	G	70. Update one's background in the philosophy of education.	51
27.0	B	7. Use a variety of assessment data to determine student readiness for science instruction (physical, intellectual, social, emotional, cultural).	50
28.0	E	50. Evaluate and analyze the performance of other teachers in the different activities of the science curriculum.	49
31.5	B	6. Design valid and reliable evaluation procedures/items that assess science instructional objectives.	48
31.5	D	20. Motivate students to learn and practice science.	48
31.5	D	27. Demonstrate major science process skills (e.g., classifying, controlling variables, designing experiments, analyzing data, etc.).	48
31.5	D	29. Plan and direct a variety of field trips in teaching science.	48
31.5	D	30. Locate and use local areas for field trips.	48
31.5	E	46. Communicate student science learning progress to the student, administrators, and parents.	48
36.5	A	4. Write learning objectives which specify manipulative and thinking skills students are to develop as a function of science instruction.	47
36.5	B	9. Arrange informal assessment situations in science teaching.	47
36.5	D	37. Use library/media center to support science instruction.	47
36.5	E	45. Keep organized student records.	47
39.0	B	8. Construct valid and reliable tests by selecting and arranging assessment items.	46
42.5	A	1. Specify a rationale for teaching science in school.	45
42.5	C	14. Develop an instructional plan for a unit (e.g., six weeks) of science instruction.	45
42.5	C	15. Select appropriate instructional strategies for science instruction, based on stated learning outcomes.	45
42.5	D	26. Demonstrate major science concepts (e.g., cycle, energy-matter, change, equilibrium, field).	45
42.5	D	31. Employ teaching strategies that clarify the values of science (e.g., demanding verification, respecting logic, considering consequences, etc.).	45

TABLE 23--Continued

Rank	Category	Item Number and Item	Frequency
42.5	D	39. Employ teaching strategies that develop in students science process skills.	45
48.0	C	18. Arrange the physical environment for science instruction.	44
48.0	D	22. Present an interdisciplinary approach to science instruction.	44
48.0	D	23. Use an inquiry teaching strategy in teaching science, when appropriate.	44
48.0	D	40. Employ teaching strategies that develop in students science manipulative skills.	44
48.0	E	43. Provide for students' safety in the science laboratory.	44
52.0	A	3. Write learning objectives which specify attitudes students are to develop as a function of science instruction.	42
52.0	D	28. Demonstrate major science manipulative skills (e.g., measuring, handling materials, maintaining materials, etc.).	42
52.0	E	49. Evaluate one's own instructional effectiveness as a science teacher.	42
54.5	B	12. Design assignments that will provide for successful learning opportunities to groups of students with varied abilities and interests.	41
54.5	C	17. Prepare and evaluate teacher-made instructional materials for science instruction.	41
56.5	D	24. Conduct a variety of science laboratory sessions.	40
56.5	D	33. Employ small group instructional strategies in teaching science.	40
58.5	B	10. Use oral questions at a variety of cognitive levels in science instruction.	38
58.5	E	44. Attend to students' physical, emotional, and social needs in science instruction.	38
59.5	D	34. Conduct group discussions/debates in teaching science.	37
59.5	E	48. Involve students in the establishment of learning goals and in decision-making in order to minimize the need for disciplinary action in science instruction.	37
63.0	A	2. Write learning objectives which specify the knowledge (both in terms of content and process) students are to develop as a function of science instruction.	33
63.0	C	16. Develop a lesson plan for a single class session.	33
63.0	D	25. Deliver a lecture/illustrated talk on a science topic.	33
65.5	B	11. Utilize assessment data on students in determining grades.	31
65.5	D	38. Present a historical perspective in the teaching of science.	31
67.0	D	32. Employ individualized instructional strategies in teaching science.	28

Note. Dashed line indicates the separation between the second third and final third of the highest-ranked items.

An examination of the first third of the highest-ranked items in Table 23 (those ranked 1.0 through 21.0) reveals that the majority belong to the areas of scientific knowledge and laboratory skills. These items are: Item 62 ranked at 1.0; Item 64 ranked at 2.0; Items 66 and 67 ranked at 3.5; Items 63 and 72 ranked at 5.5; Items 57, 68, and 73 ranked at 8.0; Item 56 ranked at 10.0; Item 65 ranked at 13.0; Item 60 ranked at 14.5; and Items 55 and 71 ranked at 16.5. It appears that the teachers had the greatest need for assistance in becoming competent in these two areas.

Items related to science instructional material were also ranked highly as shown by Item 58 ranked at 18.0, Item 35 ranked at 21.0, and Item 59 ranked at 21.0. The teachers additionally felt need for assistance in the following: using computers/teaching machines to support science instruction (Item 36, ranked at 11.0); encouraging students to undertake projects and being willing to assist and advise their efforts (Item 21, ranked at 14.5); updating one's background in the theories of development and learning (Item 69, ranked at 12.0); and managing science instructional budgets (Item 42, ranked at 21.0).

Instructional strategies and planning were not perceived as being of great need as revealed by Items 18, 23, and 40 ranked at 48.0; Item 3 ranked at 52.0; Item 17

ranked at 54.5; Item 33 ranked at 56.5; Items 10 and 44 ranked at 58.5; Item 34 ranked at 59.5; Items 2, 16, and 25 ranked at 63.0; Item 38 ranked at 65.5; and Item 32 ranked at 67.0. Some aspects of evaluation also received low rankings as indicated by Item 49 ranked at 52.0, Item 12 ranked at 54.5, Item 10 ranked at 58.5, and Item 11 ranked at 65.5. Additional low rankings were given to some aspects of delivering science instruction as revealed by Item 22 ranked at 48.0, Item 28 ranked at 52.0, and Item 24 ranked at 56.5. Similarly, some aspects of managing science instruction were ranked low, as indicated by Item 43 ranked at 48.0, Item 44 ranked at 58.5, and Item 48 ranked at 59.5.

Research Question 2: Importance of Competency

The question "What professional competencies of science instruction are most frequently identified as being of moderate or great importance to the teaching of the new science curriculum by secondary science teachers in Bahrain?" was answered by calculating, for each item, the number of people who reported that the activity described was of moderate or great importance to the teaching of the new science curriculum. The items were ranked in order according to the frequency of such responses--as shown in Table 24.

TABLE 24. Rank of Importance for Each Item by Category, Item Number, and Frequency

Rank	Category	Item Number and Item	Frequency
2.5	D	20. Motivate students to learn and practice science.	89
2.5	D	21. Encourage students to undertake projects, and be willing to assist and advise their efforts.	89
2.5	G	62. Update one's scientific knowledge in the field of teaching.	89
2.5	G	64. Update one's scientific laboratory skills in the field of teaching.	89
5.5	F	54. Organize a science laboratory room.	88
5.5	G	65. Adapt suitable new methods of scientific laboratory skills for the classroom.	88
8.0	D	40. Employ teaching strategies that develop in students science manipulative skills.	87
8.0	E	43. Provide for students' safety in the science laboratory.	87
8.0	F	55. Maintain science laboratory equipment.	87
11.0	E	46. Communicate student science learning progress to the student, administrators, and parents.	85
11.0	G	63. Incorporate the new knowledge appropriately into curriculum being taught.	85
11.0	G	72. Become a professionally-active participant in the improvement of science teaching (e.g., experienced teachers provide help and guidance for the beginning teachers; organize workshops, seminars, etc.).	85
15.0	B	10. Use oral questions at a variety of cognitive levels in science instruction.	84
15.0	D	39. Employ teaching strategies that develop in students science process skills.	84
15.0	F	57. Select and evaluate science laboratory equipment for student use, based on stated criteria.	84
15.0	G	66. Update one's knowledge of the way people utilize science/technology.	84
15.0	G	67. Update one's knowledge of science-related career opportunities for students and make these available for students.	84
20.0	D	22. Present an interdisciplinary approach to science instruction.	83
20.0	D	23. Use an inquiry teaching strategy in teaching science, when appropriate.	83
20.0	F	59. Select and evaluate supportive materials (library books, films) for science instruction, based on stated criteria.	83
20.0	F	60. Maintain live organisms for science instruction.	83
20.0	G	73. Become acquainted with the major new science programs from other countries and the way(s) in which such programs might affect the science curriculum in Bahrain.	83
24.5	D	28. Demonstrate major science manipulative skills (e.g., measuring, handling materials, maintaining materials, etc.).	82

TABLE 24--Continued

Rank	Category	Item Number and Item	Frequency
24.5	D	31. Employ teaching strategies that clarify the values of science (e.g., demanding verification, respecting logic, considering consequences, etc.).	82
24.5	D	35. Use a variety of audiovisual equipment to support science instruction.	82
24.5	F	56. Design and construct simple science laboratory equipment.	82
27.0	D	26. Demonstrate major science concepts (e.g., cycle, energy-matter, change, equilibrium, field).	80
28.0	A	3. Write learning objectives which specify attitudes students are to develop as a function of science instruction.	79
30.0	D	27. Demonstrate major science process skills (e.g., classifying, controlling variables, designing experiments, analyzing data, etc.).	79
30.0	D	30. Locate and use local areas for field trips.	79
30.0	F	58. Identify sources of free and inexpensive science instructional materials.	79
33.0	B	7. Use a variety of assessment data to determine student readiness for science instruction (physical, intellectual, social, emotional, cultural).	78
33.0	D	29. Plan and direct a variety of field trips in teaching science.	78
33.0	E	42. Manage a science instructional budget.	78
36.5	A	1. Specify a rationale for teaching science in school.	77
36.5	D	24. Conduct a variety of science laboratory sessions.	77
36.5	D	33. Employ small group instructional strategies in teaching science.	77
36.5	E	49. Evaluate one's own instructional effectiveness as a science teacher.	77
40.5	B	8. Construct valid and reliable tests by selecting and arranging assessment items.	76
40.5	D	37. Use library/media center to support science instruction.	76
40.5	E	47. Supervise a paraprofessional in the science classroom/laboratory (e.g., laboratory technician).	76
40.5	F	53. Assist in the setting up of a laboratory supply order, storage and retrieval system.	76
43.5	E	50. Evaluate and analyze the performance of other teachers in the different activities of the science curriculum.	75
43.5	G	69. Update one's background in theories of cognitive and affective development, learning, and instruction.	75
46.5	A	4. Write learning objectives which specify manipulative and thinking skills students are to develop as a function of science instruction.	74

Note. Dashed lines indicate the separations between the first third and second third, and between the second third and final third of the highest-ranked items.

TABLE 24--Continued

Rank	Category	Item Number and Item	Frequency
46.5	C	18. Arrange the physical environment for science instruction.	74
46.5	D	34. Conduct group discussions/debates in teaching science.	74
46.5	G	68. Update one's knowledge of science-related societal issues.	74
51.0	A	2. Write learning objectives which specify the knowledge (both in terms of content and process) students are to develop as a function of science instruction.	73
51.0	B	6. Design valid and reliable evaluation procedures/items that assess science instructional objectives.	73
51.0	B	9. Arrange informal assessment situations in science teaching.	73
51.0	B	12. Design assignments that will provide for successful learning opportunities to groups of students with varied abilities and interests.	73
51.0	E	45. Keep organized student records.	73
54.0	C	17. Prepare and evaluate teacher-made instructional materials for science instruction.	72
55.0	G	71. Update one's background in the philosophy of science.	71
56.0	E	51. Use a computer to manage maintain student records, create resource files, write and store assessment items, maintain inventories, and prepare grade and progress reports, etc.	69
58.0	C	15. Select appropriate instructional strategies for science instruction, based on stated learning outcomes.	68
58.0	D	36. Use computers/teaching machines to support science instruction.	68
58.0	G	70. Update one's background in the philosophy of education.	68
60.0	E	44. Attend to students' physical, emotional, and social needs in science instruction.	67
61.5	B	11. Utilize assessment data on students in determining grades.	65
61.5	E	48. Involve students in the establishment of learning goals and in decision-making in order to minimize the need for disciplinary action in science instruction.	65
63.0	D	25. Deliver a lecture/illustrated talk on a science topic.	63
64.0	C	14. Develop an instructional plan for a unit (e.g., six weeks) of science instruction.	62
65.0	C	16. Develop a lesson plan for a single class session.	59
66.0	D	38. Present a historical perspective in the teaching of science.	48
67.0	D	32. Employ individualized instructional strategies in teaching science.	40

An examination of the first third of the highest-ranked items in Table 24 (those ranked 2.5 through 24.5) reveals that the majority belong to the areas of scientific knowledge and laboratory skills. These items are: Items 62 and 64 ranked at 2.5; Items 54 and 65 ranked at 5.5; Items 40, 43, and 55 ranked at 8.0; Items 63 and 72 ranked at 11.0; Items 39, 57, 66, and 67 ranked at 15.0; Items 60 and 73 ranked at 20.0; and Items 28 and 56 ranked at 24.5.

Of the other items that were highly ranked, six were concerned with delivering science instructions. These items are: Items 20 and 21 ranked at 2.5, Items 22 and 23 ranked at 20.0, and Items 31 and 35 ranked at 24.5. The other three highly-ranked items are: Item 46 (related to communicating learning progress to the student) ranked at 11.0; Item 10 (related to oral questioning) ranked at 15.0; and Item 59 (related to selecting and evaluating supportive materials) ranked at 20.0.

Instructional strategies and planning were not perceived as being of great importance as indicated by Items 4, 18, and 34 ranked at 46.5; Item 2 ranked at 51.0; Item 17 ranked at 54.0; Item 15 ranked at 58.0; Item 25 ranked at 63.0; Item 14 ranked at 64.0; Item 16 ranked at 65.0; Item 38 ranked at 66.0, and Item 32 ranked at 67.0. The area of evaluation received low rankings as indicated by Items 6, 9, and 12

ranked at 51.0 and Item 11 ranked at 61.5. Some aspects of managing science instruction were perceived of low importance such as: Item 45 ranked at 51.0, Item 51 ranked at 56.0, Item 44 ranked at 60.0, and Item 48 ranked at 61.5. Some aspects of science teacher self-improvement were also ranked low as indicated by Item 68 ranked at 46.5, Item 71 ranked at 55.0, and Item 70 ranked at 58.0. An additional item which received a low ranking was Item 36 (related to the use of computers/teaching machines) ranked at 58.0.

Item 10 received a ranking of 15.0 on the importance scale in Table 24 which means that the teachers perceived that it was of high importance. However, this same item was perceived as being of little need as indicated by a rank of 58.5 in Table 23. Other items that showed similar discrepancies are: Item 36 with a rank of 11.0 on the need scale and 58.0 on the importance scale; Item 43 with a rank of 48.0 on the need scale and 8.0 on the importance scale; Item 68 with a rank of 8.0 on the need scale and 46.5 on the importance scale; Item 69 with a rank of 12.0 on the need scale and 43.5 on the importance scale; and Item 71 with a rank of 16.5 on the need scale and 55.0 on the importance scale.

Table 25 presents a comparison of the rankings for each item in terms of importance and need.

TABLE 25. Rank of Need and Rank of Importance
for Each Item by Item Number

Item Number and Item	Need	Importance
1. Specify a rationale for teaching science in school.	42.3	36.5
2. Write learning objectives which specify the knowledge (both in terms of content and process) students are to develop as a function of science instruction.	63.0	51.0
3. Write learning objectives which specify attitudes students are to develop as a function of science instruction.	52.0	28.0
4. Write learning objectives which specify manipulative and thinking skills students are to develop as a function of science instruction.	36.5	46.5
6. Design valid and reliable evaluation procedures/items that assess science instructional objectives.	31.5	51.0
7. Use a variety of assessment data to determine student readiness for science instruction (physical, intellectual, social, emotional, cultural).	27.0	33.0
8. Construct valid and reliable tests by selecting and arranging assessment items.	39.0	40.5
9. Arrange informal assessment situations in science teaching.	36.5	51.0
10. Use oral questions at a variety of cognitive levels in science instruction.	58.5	15.0
11. Utilize assessment data on students in determining grades.	65.5	61.5
12. Design assignments that will provide for successful learning opportunities to groups of students with varied abilities and interests.	54.5	51.0
14. Develop an instructional plan for a unit (e.g., six weeks) of science instruction.	42.5	64.0
15. Select appropriate instructional strategies for science instruction, based on stated learning outcomes.	42.5	58.0
16. Develop a lesson plan for a single class session.	63.0	65.0
17. Prepare and evaluate teacher-made instructional materials for science instruction.	54.5	54.0
18. Arrange the physical environment for science instruction.	48.0	46.5
20. Motivate students to learn and practice science.	31.5	2.5
21. Encourage students to undertake projects, and be willing to assist and advise their efforts.	14.5	2.5
22. Present an interdisciplinary approach to science instruction.	48.0	20.0
23. Use an inquiry teaching strategy in teaching science, when appropriate.	48.0	20.0
24. Conduct a variety of science laboratory sessions.	56.5	36.5
25. Deliver a lecture/illustrated talk on a science topic.	63.0	63.0

TABLE 25--Continued

Item Number and Item	Need	Importance
26. Demonstrate major science concepts (e.g., cycle, energy-matter, change, equilibrium, field).	42.5	27.0
27. Demonstrate major science process skills (e.g., classifying, controlling variables, designing experiments, analyzing data, etc.).	31.5	30.0
28. Demonstrate major science manipulative skills (e.g., measuring, handling materials, maintaining materials, etc.).	52.0	24.5
29. Plan and direct a variety of field trips in teaching science.	31.5	33.0
30. Locate and use local areas for field trips.	31.5	30.0
31. Employ teaching strategies that clarify the values of science (e.g., demanding verification, respecting logic, considering consequences, etc.).	42.5	24.5
32. Employ individualized instructional strategies in teaching science.	67.0	67.0
33. Employ small group instructional strategies in teaching science.	56.5	36.5
34. Conduct group discussions/debates in teaching science.	59.5	46.5
35. Use a variety of audiovisual equipment to support science instruction.	21.0	20.0
36. Use computers/teaching machines to support science instruction.	11.0	58.0
37. Use library/media center to support science instruction.	36.5	40.5
38. Present a historical perspective in the teaching of science.	65.5	66.0
39. Employ teaching strategies that develop in students science process skills.	48.0	15.0
40. Employ teaching strategies that develop in students science manipulative skills.	48.0	8.0
42. Manage a science instructional budget.	21.0	33.0
43. Provide for students' safety in the science laboratory.	48.0	8.0
44. Attend to students' physical, emotional, and social needs in science instruction.	58.5	60.0
45. Keep organized student records.	36.5	51.0
46. Communicate student science learning progress to the student, administrators, and parents.	31.5	11.0
47. Supervise a paraprofessional in the science classroom/laboratory (e.g., laboratory technician).	25.0	40.5
48. Involve students in the establishment of learning goals and in decision-making in order to minimize the need for disciplinary action in science instruction.	59.5	61.5
49. Evaluate one's own instructional effectiveness as a science teacher.	52.0	36.5

TABLE 25--Continued

Item Number and Item	Need	Importance
50. Evaluate and analyze the performance of other teachers in the different activities of the science curriculum.	28.0	43.5
51. Use a computer to manage maintain student records, create resource files, write and store assessment items, maintain inventories, and prepare grade and progress reports, etc.	25.0	56.0
53. Assist in the setting up of a laboratory supply order, storage and retrieval system.	21.0	40.5
54. Organize a science laboratory room.	21.0	5.5
55. Maintain science laboratory equipment.	16.5	8.0
56. Design and construct simple science laboratory equipment.	10.0	24.5
57. Select and evaluate science laboratory equipment for student use, based on stated criteria.	8.0	15.0
58. Identify sources of free and inexpensive science instructional materials.	18.0	30.0
59. Select and evaluate supportive materials (library books, films) for science instruction, based on stated criteria.	21.0	20.0
60. Maintain live organisms for science instruction.	14.5	20.0
62. Update one's scientific knowledge in the field of teaching.	1.0	2.5
63. Incorporate the new knowledge appropriately into curriculum being taught.	5.5	11.0
64. Update one's scientific laboratory skills in the field of teaching.	2.0	2.5
65. Adapt suitable new methods of scientific laboratory skills for the classroom.	13.0	5.5
66. Update one's knowledge of the way people utilize science/technology.	3.5	15.0
67. Update one's knowledge of science-related career opportunities for students and make these available for students.	3.5	15.0
68. Update one's knowledge of science-related societal issues.	8.0	46.5
69. Update one's background in theories of cognitive and affective development, learning, and instruction.	12.0	43.5
70. Update one's background in the philosophy of education.	25.0	58.0
71. Update one's background in the philosophy of science.	16.5	55.0
72. Become a professionally-active participant in the improvement of science teaching (e.g., experienced teachers provide help and guidance for the beginning teachers; organize workshops, seminars, etc.).	5.5	11.0
73. Become acquainted with the major new science programs from other countries and the way(s) in which such programs might affect the science curriculum in Bahrain.	8.0	20.0

An additional analysis was conducted to assess the dispersion of perceptions of need among subjects. For this analysis, the number of items each subject identified as being of moderate or great need for assistance was determined. The number of items per subject varied from 0 to 67 items, with a mean of 34.96. The distribution was skewed to the left, low end. Moderate or great need for assistance was reported by: 12 individuals for 0 through 9 items; 9 individuals for 10 through 19 items; 12 individuals for 20 through 29 items; 20 individuals for 30 through 39 items; 15 individuals for 40 through 49 items; and 25 individuals for 50 or more items. Those who fell into the latter group were primarily those with 10 or less years of experience in teaching; there was not a similar pattern represented for the other variables of major in college, teaching diploma attainment, and subject matter taught.

Research Question 3: Need for and Importance of Competency Categories

The question "Which categories of the competencies are perceived as being of greatest need, and which are perceived as being of greatest importance?" was answered by calculating, for each category, the average frequency of the people who reported moderate and great need, and

moderate and great importance, for the items in the category--as shown in Tables 26 and 27.

TABLE 26. Category, Average Frequency, and Rank of Need

Category	Average Frequency	Rank
A. Specifying Objectives for Science Instruction	41.75	6
B. Diagnosing and Evaluating Learners for Science Instruction	42.85	5
C. Planning Science Instruction	41.60	7
D. Delivering Science Instruction	43.95	4
E. Managing Science Instruction	45.90	3
F. Administering Science Instructional Facilities and Equipment	55.37	2
G. Science Teacher Self-Improvement	62.75	1

Category G ("Science Teacher Self-Improvement") was identified as being of the greatest need, whereas Category F ("Administering Science Instructional Facilities and Equipment") was ranked as the second highest. The difference in the average frequencies of the other categories was slight.

Category F ("Administering Science Instructional Facilities and Equipment") was perceived as being of the

greatest importance. Second in importance was Category G ("Science Teacher Self-Improvement"). However, the difference in frequency between these two is slight when compared to the difference in frequency between the second and third.

TABLE 27. Category, Average Frequency, and Rank of Importance

Category	Average Frequency	Rank
A. Specifying Objectives for Science Instruction	75.75	3
B. Diagnosing and Evaluating Learners for Science Instruction	74.57	4
C. Planning Science Instruction	67.00	6
D. Delivering Science Instruction	72.40	5
E. Managing Science Instruction	58.70	7
F. Administering Science Instructional Facilities and Equipment	82.75	1
G. Science Teacher Self-Improvement	81.25	2

Research Question 4: Teaching Experience, Nature of Preparation and Qualification, and Subject Area Taught

To more specifically address the question "Is the perception of professional competencies of science instruction by secondary science teachers in Bahrain

related to teaching experience, nature of preparation and qualification, and subject area taught?," the three main elements were divided into the following variables: years of experience in teaching, years of experience in teaching science, major in college, teaching diploma attainment, and subject area taught. Each of these variables was treated separately. For those subjects who responded to all of the items, a one-way analysis of variance was conducted on the means of each category for importance of and need for each of these variables.

Years of Experience in Teaching

As shown in Table 28, the teachers were divided into three groupings according to their years of experience in teaching.

TABLE 28. Groupings of Teachers According to Years of Experience in Teaching

Group	Variable	Frequency	Percentage
1	5 years and below	30	32.0
2	Between 5 and 10 years	28	30.1
3	10 years and above	28	30.1
Missing		7	7.5

Analysis of Competencies in Each Category

Analysis of variance on years of experience in teaching and the importance of and need for the competencies in each category is presented in Table 29. A postanalysis using the Tukey HSD Test was done for the subtables of Table 29 which showed significant results. The results of this test, as well as the means and standard deviations of the subtables, are presented in Table 30.

Years of Experience in Teaching: Discussion

Since the science teachers displayed a significant difference in their perceptions of the importance of and need for the competencies depending on their years of experience in teaching, it appears that years of experience in teaching is a factor affecting perceptions of the importance of and need for the science instruction competencies. Thus, the results do support the common assumption that years of experience is a powerful factor in teachers' perceptions regarding the importance of and need for the identified science teaching competencies.

Tables 29 and 30 indicated that, in terms of the teachers' perceived importance of and need for the items,

TABLE 29. Analysis of Variance on Years of Experience in Teaching and the Importance of and Need for Each Category

Source	Sum of Squares	df	Mean Square	f	p
Category A: Specifying Objectives for Science Instruction					
Importance--					
Between Groups	11.97	2	5.98	1.178	0.3138
Within Groups	360.63	71	5.08		
Need--					
Between Groups	68.90	2	34.45	2.994	0.0564
Within Groups	816.93	71	11.51		
Category B: Diagnosing and Evaluating Learners for Science Instruction					
Importance--					
Between Groups	2.23	2	1.12	0.123	0.8844
Within Groups	617.06	68	9.07		
Need--					
Between Groups	271.40	2	135.70	5.567	0.0057*
Within Groups	1682.10	69	24.38		
Category C: Planning Science Instruction					
Importance--					
Between Groups	2.22	2	1.11	0.158	0.8543
Within Groups	408.33	58	7.04		
Need--					
Between Groups	54.36	2	27.18	1.316	0.2771
Within Groups	1052.98	51	20.66		
Category D: Delivering Science Instruction					
Importance--					
Between Groups	315.73	2	157.86	3.114	0.0517
Within Groups	3041.70	60	50.70		
Need--					
Between Groups	4462.13	2	2231.07	8.770	0.0005*
Within Groups	12974.63	51	254.40		

*significant at .05 level.

TABLE 29--Continued

Source	Sum of Squares	<u>df</u>	Mean Square	<u>f</u>	<u>p</u>
Category E: Managing Science Instruction					
Importance--					
Between Groups	120.36	2	60.18	3.927	0.0246*
Within Groups	980.83	64	15.33		
Need--					
Between Groups	893.55	2	446.78	8.063	0.0009*
Within Groups	2825.95	51	55.41		
Category F: Administering Science Instructional Facilities and Equipment					
Importance--					
Between Groups	75.64	2	37.82	3.666	0.0309*
Within Groups	680.91	66	10.32		
Need--					
Between Groups	592.67	2	296.34	6.573	0.0027*
Within Groups	2569.66	57	45.08		
Category G: Science Teacher Self-Improvement					
Importance--					
Between Groups	186.47	2	93.23	4.273	0.0177*
Within Groups	1549.15	71	21.82		
Need--					
Between Groups	673.29	2	336.65	5.258	0.0080*
Within Groups	3649.56	57	64.03		

*significant at .05 level.

TABLE 30. Means, Standard Deviations, and Tukey HSD Test for the Significant Subtables From Table 29

Group	Variable	Sum	Mean	<u>SD</u>	Variance	<u>N</u>
Category B: Diagnosing and Evaluating Learners for Science Instruction--Need						
1	5 years and below	470.00	17.41	4.41	19.48	27
2	Between 5 and 10 years	421.00	20.05*	4.31	18.55	21
3	10 years and above	363.00	15.13	5.91	34.98	24
Total	Entire population	1254.00	17.42	5.25	27.51	72
Category D: Delivering Science Instruction--Need						
1	5 years and below	1133.00	53.95	16.11	259.45	21
2	Between 5 and 10 years	1035.00	64.69*	15.00	225.03	16
3	10 years and above	705.00	41.47	16.60	275.64	17
Total	Entire population	2873.00	53.20	18.14	328.99	54
Category E: Managing Science Instruction--Importance						
1	5 years and below	1020.00	34.16	3.65	13.31	30
2	Between 5 and 10 years	719.00	35.95*	2.87	8.26	20
3	10 years and above	550.00	32.35	5.23	27.37	17
Total	Entire population	2289.00	34.16	4.08	16.68	67
Category E: Managing Science Instruction--Need						
1	5 years and below	621.00	24.84	7.67	58.81	25
2	Between 5 and 10 years	452.00	32.29**	5.70	32.53	14
3	10 years and above	322.00	21.47	8.42	70.84	15
Total	Entire population	1395.00	25.83	8.38	70.18	54

*significantly greater than Group 3.

**significantly greater than both Group 1 and Group 3.

TABLE 30--Continued

Group	Variable	Sum	Mean	<u>SD</u>	Variance	<u>N</u>
Category F: Administering Science Instructional Facilities and Equipment--Importance						
1	5 years and below	872.00	30.07*	2.24	4.99	29
2	Between 5 and 10 years	533.00	29.61	2.52	6.37	18
3	10 years and above	609.00	27.68	4.54	20.61	22
Total	Entire population	2014.00	29.19	3.34	11.12	69
Category F: Administering Science Instructional Facilities and Equipment--Need						
1	5 years and below	568.00	22.72	8.36	69.88	25
2	Between 5 and 10 years	447.00	27.94**	3.86	14.86	16
3	10 years and above	375.00	19.74	6.09	37.20	19
Total	Entire population	1390.00	23.17	7.32	53.59	60
Category G: Science Teacher Self-Improvement--Importance						
1	5 years and below	1288.00	42.93	3.73	13.93	30
2	Between 5 and 10 years	1003.00	43.61*	3.68	13.52	23
3	10 years and above	835.00	39.76	6.51	42.30	21
Total	Entire population	3126.00	42.24	4.88	23.77	74
Category G: Science Teacher Self-Improvement--Need						
1	5 years and below	860.00	37.39	6.04	36.43	23
2	Between 5 and 10 years	794.00	39.70*	7.57	57.27	20
3	10 years and above	533.00	31.35	10.49	109.99	17
Total	Entire population	2187.00	36.45	8.56	73.27	60

*significantly greater than Group 3.

**significantly greater than both Group 1 and Group 3.

there was a significant difference between the teachers who had 10 years or more of experience in teaching and those who had less than 10 years of experience.

From the category-by-category analysis (shown in Table 29), it was found that there were no significant differences between the three groups in their responses to Categories A and C.

However, there was a significant difference between the responses of the groups in terms of their needs for assistance with the competencies in Categories B and D: Group 2, with years of experience between 5 and 10 years, showed a need for assistance in these two categories which was significantly greater than the need perceived by Group 3. In addition, Group 2 attributed significantly greater importance to Categories E and G than Group 3. Group 2 also perceived a significantly greater need than both Groups 1 and 3 in terms of Category E as well as a significantly greater need for Category G than Group 3.

In comparing the groups' responses to the competencies in Category F, the data revealed that Group 1 perceived a significantly greater importance than that of Group 3 and Group 2 perceived a significantly greater need than either of the other two groups for this same category. All other differences between the groups were not significant.

Years of Experience in Teaching Science

As shown in Table 31, the teachers were divided into three groups according to their years of experience in teaching science.

TABLE 31. Groupings of Teachers According to Years of Experience in Teaching Science

Group	Variable	Frequency	Percentage
1	5 years and below	31	33.3
2	Between 5 and 10 years	27	29.0
3	10 years and above	29	31.2
Missing		6	6.5

Analysis of Competencies in Each Category

The analysis of variance on years of experience in teaching science and the importance of and need for the competencies in each category is presented in Table 32. A postanalysis using the Tukey HSD Test was done for the subtables of Table 32 that showed significant results. The results of this test, as well as the means and standard deviations of these subtables, are shown in Table 33.

TABLE 32. Analysis of Variance on Years of Experience in Teaching Science and the Importance of and Need for Each Category

Source	Sum of Squares	df	Mean Square	<u>f</u>	<u>p</u>
Category A: Specifying Objectives for Science Instruction					
Importance--					
Between Groups	15.74	2	7.87	1.515	0.2269
Within Groups	368.82	71	5.20		
Need--					
Between Groups	66.27	2	33.14	2.918	0.0605
Within Groups	806.23	71	11.35		
Category B: Diagnosing and Evaluating Learners for Science Instruction					
Importance--					
Between Groups	2.74	2	1.37	0.155	0.8563
Within Groups	608.58	69	8.82		
Need--					
Between Groups	222.45	2	111.23	4.752	0.0116*
Within Groups	1638.59	70	23.41		
Category C: Planning Science Instruction					
Importance--					
Between Groups	3.17	2	1.59	0.223	0.8009
Within Groups	420.18	59	7.12		
Need--					
Between Groups	58.17	2	29.09	1.393	0.2575
Within Groups	1085.83	52	20.88		
Category D: Delivering Science Instruction					
Importance--					
Between Groups	224.24	2	112.12	2.205	0.1189
Within Groups	3101.51	61	50.84		
Need--					
Between Groups	3940.00	2	1970.00	7.620	0.0013*
Within Groups	13185.65	51	258.54		

*significant at .05 level.

TABLE 32--Continued

Source	Sum of Squares	df	Mean Square	f	p
Category E: Managing Science Instruction					
Importance--					
Between Groups	107.43	2	53.72	3.573	0.0337*
Within Groups	977.20	65	15.03		
Need--					
Between Groups	617.84	2	308.92	5.522	0.0067*
Within Groups	2908.89	52	55.94		
Category F: Administering Science Instructional Facilities and Equipment					
Importance--					
Between Groups	75.20	2	37.60	3.685	0.0304*
Within Groups	673.36	66	10.20		
Need--					
Between Groups	475.27	2	237.64	5.187	0.0085*
Within Groups	2611.58	57	45.82		
Category G: Science Teacher Self-Improvement					
Importance--					
Between Groups	165.28	2	82.64	3.807	0.0269*
Within Groups	1541.37	71	21.71		
Need--					
Between Groups	589.28	2	294.64	4.664	0.0133*
Within Groups	3600.91	57	63.17		

*significant at .05 level.

TABLE 33. Means, Standard Deviations, and Tukey HSD Test for the Significant Subtables From Table 32

Group	Variable	Sum	Mean	<u>SD</u>	Variance	<u>N</u>
Category B: Diagnosing and Evaluating Learners for Science Instruction--Need						
1	5 years and below	493.00	17.61	4.46	19.88	28
2	Between 5 and 10 years	389.00	19.45*	3.93	15.42	20
3	10 years and above	376.00	15.04	5.81	33.71	25
Total	Entire population	1258.00	17.23	5.08	25.85	73
Category D: Delivering Science Instruction--Need						
1	5 years and below	1214.00	55.18*	16.74	280.35	22
2	Between 5 and 10 years	874.00	62.43*	14.69	215.65	14
3	10 years and above	737.00	40.94	16.26	264.41	18
Total	Entire population	2825.00	52.31	17.98	323.13	54
Category E: Managing Science Instruction--Importance						
1	5 years and below	1058.00	34.13*	3.66	13.38	31
2	Between 5 and 10 years	678.00	35.68*	2.75	7.56	19
3	10 years and above	581.00	32.28	5.09	25.86	18
Total	Entire population	2317.00	34.07	4.02	16.19	68
Category E: Managing Science Instruction--Need						
1	5 years and below	649.00	25.35	7.94	63.11	26
2	Between 5 and 10 years	403.00	31.00*	5.16	26.67	13
3	10 years and above	348.00	21.75	8.21	67.40	16
Total	Entire population	1410.00	25.64	8.08	65.31	55

*significantly greater than Group 3.

TABLE 33--Continued

Group	Variable	Sum	Mean	<u>SD</u>	Variance	<u>N</u>
Category F: Administering Science Instructional Facilities and Equipment--Importance						
1	5 years and below	903.00	30.10*	2.20	4.85	30
2	Between 5 and 10 years	499.00	29.35	2.50	6.24	17
3	10 years and above	609.00	27.68	4.54	20.61	22
Total	Entire population	2011.00	29.14	3.32	11.01	69
Category F: Administering Science Instructional Facilities and Equipment--Need						
1	5 years and below	599.00	23.04	8.35	69.72	26
2	Between 5 and 10 years	409.00	27.27*	3.77	37.20	15
3	10 years and above	375.00	19.74	6.10	37.20	19
Total	Entire population	1385.00	23.05	7.23	52.32	60
Category G: Science Teacher Self-Improvement--Importance						
1	5 years and below	1334.00	43.03*	3.71	13.77	31
2	Between 5 and 10 years	949.00	43.14*	3.66	13.36	22
3	10 years and above	835.00	39.76	6.51	42.39	21
Total	Entire population	3118.00	42.14	4.84	23.38	74
Category G: Science Teacher Self-Improvement--Need						
1	5 years and below	906.00	37.75*	6.16	37.93	24
2	Between 5 and 10 years	738.00	38.84*	7.34	53.81	19
3	10 years and above	533.00	31.35	10.49	109.99	17
Total	Entire population	2177.00	36.28	8.43	71.02	60

*significantly greater than Group 3.

Years of Experience in Teaching
Science: Discussion

Here again the results support the common belief that years of experience is a powerful factor in the perceptions of teachers toward the importance of and need for the identified science teaching competencies.

Tables 32 and 33 indicated that there was a significant difference in the teachers' perceived importance of and need for the items between the teachers who had 10 years or more of experience in teaching science and those who had less than 10 years of experience.

From the category-by-category analysis (shown in Table 32), it was found that there were no significant differences between the three groups in their responses to Categories A and C.

However, there was a significant difference between the responses of the groups in the need for assistance with the competencies in Categories B and D. In Category B, Group 2 showed a need for assistance which was significantly greater than that of Group 3. In Category D, Group 1 and Group 2 showed a need for assistance which was significantly greater than that of Group 3.

In addition, Group 2 perceived an importance and need significantly greater than that of Group 3 for the

competencies in Category E as well as for those in the need section of Category F. Group 1 perceived an importance which was significantly greater than Group 3 for the competencies in Categories E and F.

Group 1 and Group 2 expressed an importance and need which was significantly greater than that of Group 3 for the competencies presented in Category G. All other differences between groups were not significant.

Major in College

The teachers were divided into groupings according to their majors when they were university students as shown in Table 34. Of the 6 "others," 4 majored in general

TABLE 34. Groupings of Teachers According to Major in College

Group	Variable	Frequency	Percentage
1	Biology	15	16.1
2	Chemistry	18	19.4
3	Physics	9	9.7
4	Biology/Chemistry	21	22.6
5	Chemistry/Physics	19	20.4
Others		6	6.5
Missing		5	5.4

science and 2 in geology. Due to the small numbers these cases were excluded from the analysis.

Analysis of Competencies in Each Category

The analysis of variance on the teachers' majors in college and the importance of and need for the competencies of each category is presented in Table 35. A postanalysis using the Tukey HSD Test was done for the need section of Category F, which was the only significant subtable of Table 35. The results of this test, as well as the means and standard deviations of the values in this category, are presented in Table 36.

Major in College: Discussion

From the analysis of the differences between the responses of the teachers according to major in college (Table 35), the only significant difference found was in the need section of Category F. The Tukey HSD Test (Table 36) showed that biology teachers had a significantly higher mean than that of chemistry teachers and that biology/chemistry teachers had a significantly higher mean than that of chemistry teachers. This indicated that biology teachers and biology/chemistry teachers perceived greater need for assistance than

TABLE 35. Analysis of Variance on Major in College and the Importance of and Need for Each Category

Source	Sum of Squares	df	Mean Square	<u>f</u>	<u>p</u>
Category A: Specifying Objectives for Science Instruction					
Importance--					
Between Groups	37.76	4	9.44	1.864	0.1270
Within Groups	339.35	67	5.07		
Need--					
Between Groups	23.10	4	5.82	0.459	0.7656
Within Groups	850.36	67	12.69		
Category B: Diagnosing and Evaluating Learners for Science Instruction					
Importance--					
Between Groups	25.65	4	6.41	0.707	0.5903
Within Groups	580.64	64	9.67		
Need--					
Between Groups	73.06	4	18.26	0.636	0.6387
Within Groups	1866.72	65	28.72		
Category C: Planning Science Instruction					
Importance--					
Between Groups	29.02	4	7.25	1.026	0.4019
Within Groups	395.90	56	7.07		
Need--					
Between Groups	31.34	4	7.82	0.361	0.8348
Within Groups	1040.66	48	21.68		
Category D: Delivering Science Instruction					
Importance--					
Between Groups	214.49	4	53.62	0.986	0.4226
Within Groups	3155.73	58	54.41		
Need--					
Between Groups	2562.85	4	640.71	2.253	0.0768
Within Groups	13931.69	49	284.32		

TABLE 35--Continued

Source	Sum of Squares	<u>df</u>	Mean Square	<u>f</u>	<u>p</u>
Category E: Managing Science Instruction					
Importance--					
Between Groups	51.06	4	12.76	0.717	0.5835
Within Groups	1049.81	59	17.79		
Need--					
Between Groups	497.23	4	124.31	2.164	0.0880
Within Groups	2642.45	46	57.45		
Category F: Administering Science Instructional Facilities and Equipment					
Importance--					
Between Groups	20.76	4	5.19	0.486	0.7459
Within Groups	661.93	62	10.68		
Need--					
Between Groups	691.29	4	172.82	4.091	0.0059*
Within Groups	2196.85	52	42.25		
Category G: Science Teacher Self-Improvement					
Importance--					
Between Groups	60.62	4	15.16	0.661	0.6215
Within Groups	1513.10	66	22.94		
Need--					
Between Groups	227.44	4	56.86	0.760	0.5559
Within Groups	3964.63	53	74.80		

*significant at .05 level.

TABLE 36. Means, Standard Deviations, and Tukey HSD Test for the Need Section Values in Category F From Table 35

Group	Variable	Sum	Mean	<u>SD</u>	Variance	<u>N</u>
1	Biology	315.00	26.25*	5.83	34.02	12
2	Chemistry	269.00	17.93	8.42	70.92	15
3	Physics	77.00	25.67	6.03	36.33	3
4	Biology/Chemistry	395.00	26.33*	5.37	28.81	15
5	Chemistry/Physics	286.00	23.83	5.67	32.15	12
Total	Entire population	1342.00	23.54	7.18	51.57	57

*significantly greater than Group 2.

chemistry teachers in order to become competent in administering science instructional facilities and equipment. All other differences between groups were not significant.

Teaching Diploma Attainment

Analysis of Competencies in Each Category

The analysis of variance on teaching diploma attainment and the importance of and need for the competencies in each category is presented in Table 37.

TABLE 37. Analysis of Variance on Teaching Diploma Attainment and the Importance of and Need for Each Category

Source	Sum of Squares	df	Mean Square	<u>f</u>	<u>p</u>
Category A: Specifying Objectives for Science Instruction					
Importance--					
Between Groups	2.93	1	2.93	0.552	0.4597
Within Groups	381.93	72	5.31		
Need--					
Between Groups	10.30	1	10.30	0.850	0.3596
Within Groups	884.37	73	12.12		
Category B: Diagnosing and Evaluating Learners for Science Instruction					
Importance--					
Between Groups	28.57	1	28.57	3.323	0.0727
Within Groups	584.70	68	8.60		
Need--					
Between Groups	1.13	1	1.13	0.041	0.8402
Within Groups	1932.87	70	27.61		
Category C: Planning Science Instruction					
Importance--					
Between Groups	4.58	1	4.58	0.647	0.4246
Within Groups	403.66	57	7.08		
Need--					
Between Groups	4.34	1	4.34	0.204	0.6532
Within Groups	1061.72	50	21.23		
Category D: Delivering Science Instruction					
Importance--					
Between Groups	6.83	1	6.83	0.128	0.7215
Within Groups	3303.28	62	53.28		
Need--					
Between Groups	0.00	1	0.00	0.000	0.9987
Within Groups	17223.75	53	324.98		

TABLE 37--Continued

Source	Sum of Squares	df	Mean Square	<u>f</u>	<u>p</u>
Category E: Managing Science Instruction					
Importance--					
Between Groups	12.30	1	12.30	0.796	0.3755
Within Groups	988.79	64	15.45		
Need--					
Between Groups	38.11	1	38.11	0.542	0.4650
Within Groups	3586.64	51	70.33		
Category F: Administering Science Instructional Facilities and Equipment					
Importance--					
Between Groups	8.81	1	8.81	0.792	0.3767
Within Groups	756.28	68	11.12		
Need--					
Between Groups	27.08	1	27.08	0.505	0.4800
Within Groups	3107.78	58	53.58		
Category G: Science Teacher Self-Improvement					
Importance--					
Between Groups	6.85	1	6.85	0.294	0.5895
Within Groups	1702.83	73	23.33		
Need--					
Between Groups	4.63	1	4.63	0.061	0.8053
Within Groups	4378.22	58	75.49		

Teaching Diploma Attainment:
Discussion

The science teachers did not display a significant difference in the importance of and need for the competencies dependent upon whether or not they had attained teaching diplomas. That is, the results indicated that there were no significant differences between teachers who had attained teaching diplomas and those who had not--in terms of their perceived importance of and need for the competencies presented by the items.

Subject Area Taught

The groupings of the teachers by subject area taught are presented in Table 38. The analyses of variance within this section were carried out using the three major categories of biology, chemistry, and physics.

TABLE 38. Groupings of Teachers According to
 Subject Area Taught

Group	Variable	Frequency	Percentage
1	Biology	20	21.5
2	Chemistry	19	20.4
3	Physics	26	27.9

Analysis of Competencies in Each Category

An analysis of variance on subject area taught and the importance of and need for the competencies of each category is presented in Table 39. A postanalysis using the Tukey HSD Test was done for the need section of Category G in Table 39. The results of this analysis, as well as the means and standard deviations of the values in Table 39, are presented in Table 40.

Subject Area Taught: Discussion

The results indicated that subject area taught was not a powerful factor in determining the teachers' perceived importance of and need for the competencies of science teaching. The need for teacher self-improvement (Category G) was the only significant difference found between the groups. The teachers who taught physics felt a need for assistance with the competencies presented in this category to a significantly greater degree than that expressed by the teachers who taught chemistry. All other differences between groups were not significant.

TABLE 39. Analysis of Variance on Subject Area Taught and the Importance of and Need for Each Category

Source	Sum of Squares	df	Mean Square	f	p
Category A: Specifying Objectives for Science Instruction					
Importance--					
Between Groups	2.50	2	1.30	0.224	0.7997
Within Groups	323.91	56	5.78		
Need--					
Between Groups	31.15	2	15.58	1.321	0.2751
Within Groups	660.38	56	11.79		
Category B: Diagnosing and Evaluating Learners for Science Instruction					
Importance--					
Between Groups	9.94	2	4.97	0.549	0.5808
Within Groups	461.40	51	9.05		
Need--					
Between Groups	123.72	2	61.86	2.388	0.1018
Within Groups	1346.83	52	25.90		
Category C: Planning Science Instruction					
Importance--					
Between Groups	16.15	2	8.08	1.068	0.3525
Within Groups	322.95	44	7.57		
Need--					
Between Groups	11.47	2	5.74	0.275	0.7613
Within Groups	814.65	39	20.89		
Category D: Delivering Science Instruction					
Importance--					
Between Groups	279.73	2	139.87	2.321	0.1096
Within Groups	2772.19	46	60.27		
Need--					
Between Groups	453.69	2	226.85	0.696	0.5046
Within Groups	13040.35	40	326.01		

TABLE 39--Continued

Source	Sum of Squares	<u>df</u>	Mean Square	<u>f</u>	<u>p</u>
Category E: Managing Science Instruction					
Importance--					
Between Groups	64.13	2	32.06	1.443	0.2461
Within Groups	1088.88	49	22.22		
Need--					
Between Groups	114.71	3	57.35	0.836	0.4413
Within Groups	2537.07	37	68.57		
Category F: Administering Science Instructional Facilities and Equipment					
Importance--					
Between Groups	4.73	2	2.37	0.230	0.7953
Within Groups	524.03	51	10.28		
Need--					
Between Groups	260.88	2	130.44	2.497	0.0939
Within Groups	2298.61	44	52.24		
Category G: Science Teacher Self-Improvement					
Importance--					
Between Groups	10.94	2	5.47	0.200	0.8197
Within Groups	1398.32	51	27.42		
Need--					
Between Groups	507.62	2	253.81	4.008	0.0257*
Within Groups	2596.56	41	63.33		

*significant at .05 level.

TABLE 40. Means, Standard Deviations, and
Tukey HSD Test for the Need Section Values
in Category G From Table 39

Group	Variable	Sum	Mean	<u>SD</u>	Variance	<u>N</u>
1	Biology	548.00	36.53	6.59	43.41	15
2	Chemistry	398.00	30.62	10.53	110.92	13
3	Physics	622.00	38.88*	6.62	43.85	16
Total	Entire population	1568.00	35.64	8.50	72.19	44

*significantly greater than Group 2.

Open-Ended Questionnaire Items

The teachers were given the opportunity to add competencies into each category by responding to the open-ended questionnaire items numbered 5, 13, 19, 41, 52, 61, and 74. There were 11 teachers who responded to these questions; the 11 teachers provided a total number of 20 responses. The numbers of responses for each category were as follows: for Category A, 3 responses; for Category B, 3 responses; for Category C, 2 responses; for Category D, 1 response; for Category E, 3 responses; for Category F, 2 responses; and for Category G, 5 responses.

The majority of the responses were concerned with Category G ("Science Teacher Self-Improvement"). The comments tended to be general and in some cases stated as

recommendations. Of the responses to Category G, one teacher suggested that attending the classes of other teachers and establishing a continuous dialogue between science teachers may improve science teaching. Others emphasized the need for in-service training, workshops, and providing scholarships for teachers.

CHAPTER V

SUMMARY, IMPLICATIONS, AND
RECOMMENDATIONS

The purpose of this study was to investigate Bahraini secondary school science teachers' perceived need for assistance in the development of identified science teaching competencies and the perceived importance of these competencies in teaching the new science curriculum.

Four major questions addressed by this study focused on: (a) an item-by-item analysis on the perceived need of assistance for the competencies; (b) an item-by-item analysis on the perceived importance of the competencies; (c) an analysis of the competency categories on the perceived need of assistance for and the perceived importance of the competencies; and (d) the relationships between the perceived need of assistance for and importance of the competencies and certain personal and institutional factors (i.e., years of experience in teaching, years of experience in teaching science, major in college, teaching diploma attainment, and subject area taught).

Summary

Research Question 1: What Professional Competencies of Science Instruction are Most Frequently Identified as Being of Moderate or Great Need by Secondary Science Teachers in Bahrain?

The teachers expressed high needs for updating their scientific knowledge and laboratory skills as shown by the high rankings given to the competencies specifying updating one's: scientific knowledge in the field of teaching; scientific laboratory skills in the field of teaching; knowledge of the way people utilize science/technology; knowledge of science-related career opportunities for students and making these available to students; knowledge of science-related societal issues; acquaintance with the major new science programs from other countries; and background in the philosophy of science.

Equally important, the teachers expressed a high need for incorporating the above knowledge and skills into the teaching practice as shown by the high rankings given to the following competencies: incorporating the new knowledge appropriately into the curriculum being taught; becoming a professionally-active participant in the improvement of science teaching; selecting and evaluating science laboratory equipment for student use; designing

and constructing simple science laboratory equipment; adapting suitable new methods of scientific laboratory skills for the classroom; maintaining live organisms for science instruction; maintaining science laboratory equipment; assisting in the setting up of a laboratory supply order, storage, and retrieval system; and organizing a science laboratory room.

The teachers reported a high need for the competency items related to science instructional materials, that is: identifying sources of free and inexpensive science instructional materials; using a variety of audiovisual equipment to support science instruction; and selecting and evaluating supportive materials for science instruction.

Other items which were ranked as highly needed were: using computers/teaching machines to support science instruction; updating one's background in the theories of cognitive and affective development, learning, and instruction; and managing a science instructional budget.

Low need was expressed for some aspects of planning and teaching strategies, such as: arranging the physical environment; using an inquiry teaching strategy; employing teaching strategies that develop students' science manipulative skills; writing learning objectives which

specify the attitudes students are to develop; preparing and evaluating teacher-made instructional materials; employing small-group instructional strategies; conducting group discussion/debates; writing learning objectives which specify the knowledge students are to develop; developing a lesson plan for a single class session; delivering a lecture/illustrated talk; presenting a historical perspective; and employing individualized instructional strategies.

Some aspects of evaluation (such as evaluating one's own instructional effectiveness, designing assignments, using oral questions, and utilizing assessment data on students in determining grades) were also ranked low.

Similarly, some aspects of delivering science instruction were ranked low (such as presenting an interdisciplinary approach, demonstrating major science manipulative skills, and conducting a variety of science laboratory sessions).

In addition, low rankings were attributed to some aspects of managing science instruction (such as providing for students' safety in the science laboratory; attending to students' physical, emotional, and social needs; and involving students in the establishment of learning goals and in decision-making).

Research Question 2: What Professional Competencies
of Science Instruction are Most Frequently
Identified as Being of Moderate or Great
Importance to the Teaching of the New
Science Curriculum by Secondary
Science Teachers in Bahrain?

The teachers expressed greatest perceived importance for competencies related to updating their scientific knowledge and laboratory skills as shown by the high rankings given to the competencies specifying updating one's: scientific knowledge in the field of teaching; scientific laboratory skills in the field of teaching; knowledge of the way people utilize science/technology; knowledge of science-related career opportunities for students and making these available to students; and acquaintance with the major new science programs from other countries.

Equally important, the teachers expressed a high importance for incorporating the above knowledge and skills into the teaching practice as shown by the high rankings given to the following competencies: organizing a science laboratory room; adapting suitable new methods of scientific laboratory skills for the classroom; employing teaching strategies that develop students' science manipulative skills; providing for students' safety in the science laboratory; maintaining science

laboratory equipment; incorporating the new knowledge appropriately into the curriculum being taught; becoming a professionally-active participant in the improvement of science teaching; employing teaching strategies that develop students' science process skills; selecting and evaluating science laboratory equipment for student use; maintaining live organisms for science instruction; demonstrating major science manipulative skills; and designing and constructing simple science laboratory equipment.

The teachers attributed high importance to some aspects of delivering science instruction, such as: motivating students to learn and practice science; encouraging students to undertake projects and being willing to assist and advise their efforts; presenting an interdisciplinary approach to science instruction; using an inquiry teaching strategy in teaching science; employing teaching strategies that clarify the values of science; using a variety of audiovisual equipment to support science instruction; communicating student science-learning progress to the student, administrators, and parents; using oral questions at a variety of cognitive levels in science instruction; and selecting and evaluating supportive materials for science instruction.

Low importance was expressed for items related to some aspects of planning and instructional strategies, such as: writing learning objectives which specify the manipulative and thinking skills students are to develop; arranging the physical environment; conducting group discussion/debates; writing learning objectives which specify the knowledge students are to develop; preparing and evaluating teacher-made instructional materials; selecting appropriate instructional strategies; delivering a lecture/illustrated talk; developing an instructional plan for a unit; developing a lesson plan for a single class session; presenting a historical perspective; and employing individualized instructional strategies.

Some aspects of evaluation (such as designing valid and reliable evaluation procedures/items, arranging informal assessment situations, designing assignments, and utilizing assessment data on students in determining grades) were ranked low.

Similarly, some aspects related to science teacher self-improvement (such as updating one's knowledge of science-related societal issues, updating one's background in the philosophy of science, and updating one's background in the philosophy of education) were ranked low. An additional item that was ranked low was using

computers/teaching machines to support science instruction.

Research Question 3: Which Categories of the
Competencies are Perceived as Being
of Greatest Need, and Which
are Perceived as Being of
Greatest Importance?

Science teachers expressed different degrees of need for assistance in becoming competent in the seven competency categories. Category G, "Science Teacher Self-Improvement", was ranked first. The second most-needed category was Category F, "Administering Science Instructional Facilities and Equipment." The category which ranked as the third most-needed was Category E, "Managing Science Instruction." The other categories were ranked as follows: Category D, "Delivering Science Instruction," was ranked fourth; Category B, "Diagnosing and Evaluating Learners for Science Instruction," was ranked fifth; Category A, "Specifying Objectives for Science Instruction," was ranked sixth; and Category C, "Planning Science Instruction," was ranked seventh.

In terms of the importance of the categories for the teaching of the new science curriculum, the teachers ranked Category F, "Administering Science Instructional Facilities and Equipment," first and Category G, "Science

Teacher Self-Improvement," second. The remaining categories were ranked as follows: Category A, "Specifying Objectives for Science Instruction," ranked third; Category B, "Diagnosing and Evaluating Learners for Science Instruction," was ranked fourth; Category D, "Delivering Science Instruction," was ranked fifth; Category C, "Planning Science Instruction," was ranked sixth; and Category E, "Managing Science Instruction," was ranked seventh.

Research Question 4: Is the Perception of
Professional Competencies of Science
Instruction by Secondary Science
Teachers in Bahrain Related to
Teaching Experience, Nature of
Preparation and Qualification,
and Subject Area Taught?

Concerning years of experience in teaching and years of experience in teaching science, the results supported the common assumption that years of experience is a powerful factor in determining the perceived importance of and need for the competencies. The results also indicated that teachers with 10 and more years of experience perceived significantly less importance of and need for the competencies.

Concerning major in college, significant differences were found between the groups in their assessment of

overall importance of and need for all of the competencies. Biology majors, biology/chemistry majors, and chemistry/physics majors expressed a significantly greater need for assistance and importance of the competencies than teachers who majored in chemistry. Biology majors and chemistry/physics majors expressed a significantly greater need for the overall competencies than chemistry teachers. In addition, the biology majors and biology/chemistry majors expressed a significantly greater need for administering science instructional facilities and equipment than chemistry teachers.

The results indicated that attaining a teaching diploma was not a factor in determining perceptions of need or importance.

Concerning subject area taught, the only significant difference found was in the need for science teacher self-improvement. Physics teachers expressed significantly greater need for improving themselves than did the chemistry teachers.

Implications for In-Service Programs

In general, the teachers agreed that the competencies related to teaching skills and instructional process were important. Their perceptions of a need for assistance

were not as great, although a considerable number of subjects indicated a moderate to great need for assistance with more than one-half of the competencies. The results of this study indicated that the secondary school science teachers in Bahrain perceived needs for self-improvement in areas related to scientific knowledge and laboratory skills; in some aspects of administering science instructional facilities and equipment; as well as in using computer/teaching machines to support science instruction, encouraging students to undertake projects (and being willing to assist and advise their efforts), using a variety of audiovisual equipment to support science instruction, and managing a science instructional budget.

According to Horn (1976), Voelker (1977), and Fullan (1982), one of the factors affecting the success of in-service programs is whether or not they address the perceived needs of teachers. It is essential for an in-service program's success that it be developed in such a way as to address the teacher/participants' needs.

The results of the study indicated that, during in-service programs, special attention should be directed toward the general group of teachers who possess less than 10 years of experience in teaching as well as toward the

more specific groups of physics teachers, biology majors, chemistry/physics majors, and biology/chemistry majors. These teachers expressed greater needs in particular areas than did the rest of the population.

Furthermore, the author suggests that the provision of supplemental programs for self-improvement, such as sabbatical leaves and scholarships, may be additionally helpful.

Recommendations for Further Study

1. This study was conducted using a population of secondary school science teachers from different Arab countries who were teaching in Bahrain; it might be of value to replicate this study: (a) using a larger population from a greater diversity of Arab countries and (b) with teachers from elementary and intermediate levels.

2. It is also suggested that an analysis of training programs for science teachers, in light of this study's results, may yield interesting and beneficial information.

3. As the findings from this study are integrated into staff-development programs for science education in Bahrain, special attention should be given to identification of teachers who indicate the broadest ranges of need.

APPENDIX A

LETTER TO ASSISTANT DIRECTOR OF
CURRICULUM AND TRAINING



UNIVERSITY OF OREGON

١ مايو ١٩٨٥ م

حضرة العامل السيد علي بوشيت المحترم
الوكيل المساعد للمناهج والتدريب
وزارة التربية والتعليم - المنامة

تحية طيبة وبعد ،

بالإشارة الى الخطاب الذي قمت بإرساله في منتصف شهر يناير ٨٥ الى السيد مدير ادارة المناهج بالوزارة بشأن ساعده الوزاره لي في توريد اسممـــــاره الاستبيان الذي تم اعداده على مدرسي ومدرسات العلوم في المرحلة الثانوية في مدارس الدوله ، وذلك للحصول على آراياتهم بشأن ما ذكر فيه من أسئلة تمهيدا لاعداد الدراسة التي اعزم تقديمها للحصول على شهادة الدكتوراه من جامعة أوريجون بالولايات المتحدة الأمريكية .

وبناء على المكالمه الهاتفية التي أعيت رساله ، والتي بينت فيها السيد المدير موافقة ادارته بشأن تقديم كل السهلات المطلوبة من ناحية استلام الوزارة للاستبيان وتوزيعه على المدرسين والمدرسات المعنيين واستلامه في موعد محدد .

وعليه فاني أرفق طيه عدد (١٣٠) نسخة من الاسمان المشار اليه أعلاه للعمل باتخاذ التوجيهات اللازمة بشأن توريده على مدرسي العلوم في مدارس الطلبة والطالبات للمرحلة الثانوية ، للحصول على آراياتهم المطلوبة .



UNIVERSITY OF OREGON

- ٢ -

وانتي اكون شاكرة لو تفعلتم بتأكيد ضرورة استلام الردود في موعد
أرجو أن لا يتجاوز نهاية شهر مايو الحالي وذلك كي يتسنى لمن يتابع للشي
الموضوع في البحرين جمع نسخ الاستبيان مرة أخرى وإرسالها لي حتى أستطيع
أن أسهي أبواب الأطروحة في الموعد المحدد لها .

شاكراً ومقدرة لكم حسن تعاونكم .

تفعلوا بقبول فائق التقدير والامتنان ...

فاطمة خليفة مطهر
مديرة

Associate Dean (503) 686-3404 • Elementary Education (503) 686-4591 • Secondary Education (503) 686-3481 • Special Education (503) 686-5521

DIVISION OF TEACHER EDUCATION • COLLEGE OF EDUCATION • EUGENE, OREGON 97403-1215

For Equal Opportunity Affirmative Action Statement

APPENDIX B

LETTER FROM HEAD SUPERVISOR
OF SCIENCE TEACHERS

دولة البحرين
وزارة التربية والتعليم
إدارة المناهج
شعبة العلوم

المقررة

الأستاذ/ الاستاذة مدير/ مديرة مدرسة

تحية طيبة وبعد:

تفوز الأستاذة فاطمة خليفة مطر الحاضرة بقطاع البحرين الجامعية العلوم والتدريب والتربية بإعداد دراسة لنيل درجة الدكتوراة من جامعة أريزونا بالولايات المتحدة الأمريكية ، وموضوع دراستها "الاحتياجات المهنية لمدرسي العلوم في المدارس الثانوية في البحرين".

ولما كانت هذه الدراسة ذات صلة وثيقة بمناهج العلوم في البحرين والمدرسين ،

وبناء على توجيهات الأستاذ الركيل المساعد للمناهج والتدريب ،

نرجو شعبة العلوم من جميع مدرسي /مدرسات العلوم بمدرستكم أنه يقوم كل منهم بإعداد رأيهم فيها واقعياً في هذا الاستبيان ، ونأمل من مدرسي ومدرسات العلوم الاهتمام بهذا الأمر لما له من صلة بالتطوير مستقبل تدريس العلوم بالمدارس الثانوية في البحرين .

وتفضلوا بقبول فائقه الشكر والتقدير .

المستشار

إيمان بعمل الوفاء في الذيل للمناهج للعلوم

١٩٨٥/٥/٨

APPENDIX C

SAMPLE QUESTIONNAIRE



UNIVERSITY OF OREGON

Fatima Matar
Division of Teacher Education
Eugene, Oregon 97403
U.S.A.

March 1985

Dear Science Teacher:

I am a doctoral student at the University of Oregon, in the U.S.A., on leave from Bahrain University College. I am conducting a study about the professional needs of secondary school science teachers in Bahrain. The purpose of the study is to obtain data in regard to these needs as related to the newly-adopted science curriculum.

Your cooperation in filling out the enclosed Demographic Information and Instrument questionnaire is essential to the success of this study. The instructions regarding the completion of the questionnaire precede it.

I assure you that there will be no mention of individual teachers or schools in this study, and all data will be confidential.

Please indicate in the appropriate space, provided at the end of the Demographic Information section, whether you are interested in receiving a copy of the results of this study. I will be glad to send this to you as soon as the study is completed.

Thank you for your cooperation.

Sincerely yours,

Fatima Matar

Associate Dean (503) 686-3404 • Elementary Education (503) 686-4591 • Secondary Education (503) 686-3481 • Special Education (503) 686-5521

DIVISION OF TEACHER EDUCATION • COLLEGE OF EDUCATION • EUGENE, OREGON 97403-1215

An Equal Opportunity, Affirmative Action Institution

Demographic Information--1

DEMOGRAPHIC INFORMATION

1. Name (optional): _____
2. Gender: _____ male _____ female
3. Total number of years of teaching experience, including this year:
_____ years
4. Total number of years of teaching science (including years where
you taught science as one of the subjects among other subjects
that you were supposed to teach): _____ years
5. Number of periods you teach per week this year: _____ periods
6. Number of periods you teach science per week this year:
_____ periods
7. Educational degrees received (please check, ☒, the ones that
apply); also indicate the field in which the degree was received
(e.g.: Bachelor's Degree ☒ Biology).

<u>Degree</u>		<u>Primary Field of Study</u>
Secondary Certificate	_____	_____
Teacher Training College Diploma	_____	_____
Bachelor's Degree	_____	_____
Graduate Degree	_____	_____
Others (please specify):		
_____	_____	_____
_____	_____	_____

Demographic Information--2

8. Did your training include special preparation for teaching?
 _____yes _____no
9. Are you working toward a degree in science or science education?
 _____yes _____no
10. Circle the grade level(s) of the science courses that you are presently teaching and indicate section (e.g., scientific, literary, commercial, health science, etc.) as well as number of classes taught. If you are teaching other levels or courses not indicated, please add:

<u>Course</u>	Secondary Grades		<u>Section</u>	<u>Number of Classes Taught</u>
	<u>Level</u>			
Biology	1st		_____	_____
	2nd		_____	_____
	3rd		_____	_____
Chemistry	1st		_____	_____
	2nd		_____	_____
	3rd		_____	_____
Geology	1st		_____	_____
	2nd		_____	_____
	3rd		_____	_____
Physics	1st		_____	_____
	2nd		_____	_____
	3rd		_____	_____
Other Courses (please specify)	<u>Level</u>		<u>Section</u>	<u>Number of Classes</u>
_____	_____		_____	_____
_____	_____		_____	_____
_____	_____		_____	_____

12. Do you want to receive a copy of the findings of this study?
 _____yes _____no

Instrument Instructions--1

INSTRUMENT INSTRUCTIONS

This instrument contains statements describing activities done by science teachers. Next to each statement are two graded scales.

The first scale addresses the importance of the activity described by each statement in teaching the new science curriculum. The scale is coded into:

- 1 = This activity is not important.
- 2 = This activity is of little importance.
- 3 = This activity is moderately important.
- 4 = This activity is of great importance.

Please respond by circling one of the above codes for each statement.

The second scale addresses your need for assistance to become competent in the particular activity described by each statement in your teaching of science. This assistance might be provided through in-service training, personal help, or further study. The codes of this scale are:

- 5 = I have no need for assistance.
- 6 = I have little need for assistance.
- 7 = I have a moderate need for assistance.
- 8 = I have a great need for assistance.

Please respond by circling one of the above codes for each statement.

Instrument Instructions--2

Example 1:

Employing concept attainment teaching strategy in science instruction.

importance				need			
①	2	3	4	5	⑥	7	8

The science teacher who responded to the statement above felt that it was not important to employ this teaching strategy in teaching the new curriculum, and that he or she had little need for assistance to become competent in this teaching strategy.

Example 2:

Using the Van de Graff generator to teach electricity.

importance				need			
1	2	③	4	5	6	7	⑧

The science teacher who responded to the statement above felt that it is moderately important to use the Van de Graff generator to teach electricity in the new science curriculum, and that he or she has a great need for assistance in knowing how to use it.

Please respond to the two scales in the 74 items that follow by circling one response from each. Be sure to circle two responses--both the level of importance and need. If you are unable to respond to an item (or items) because you are not familiar with the activity described, please list the number at the end of the instrument.

Page 1

	Not Important 1	Little Importance 2	Moderately Important 3	Great Importance 4	No Need 5	Little Need 6	Moderate Need 7	Great Need 8
	IMPORTANCE				NEED			
A. SPECIFYING OBJECTIVES FOR SCIENCE INSTRUCTION								
1. Specify a rationale for teaching science in school.	1	2	3	4	5	6	7	8
2. Write learning objectives which specify the knowledge (both in terms of content and process) students are to develop as a function of science instruction.	1	2	3	4	5	6	7	8
3. Write learning objectives which specify attitudes students are to develop as a function of science instruction.	1	2	3	4	5	6	7	8
4. Write learning objectives which specify manipulative and thinking skills students are to develop as a function of science instruction.	1	2	3	4	5	6	7	8
5. What other needs, relative to specifying objectives for science instruction, do you have? (Please list them below and rate each.)								
B. DIAGNOSING AND EVALUATING LEARNERS FOR SCIENCE INSTRUCTION								
6. Design valid and reliable evaluation procedures/items that assess science instructional objectives.	1	2	3	4	5	6	7	8
7. Use a variety of assessment data to determine student readiness for science instruction (physical, intellectual, social, emotional, cultural).	1	2	3	4	5	6	7	8

Page 2

	Not Important 1	Little Importance 2	Moderately Important 3	Great Importance 4	No Need 5	Little Need 6	Moderate Need 7	Great Need 8
	IMPORTANCE				NEED			
8. Construct valid and reliable tests by selecting and arranging assessment items.	1	2	3	4	5	6	7	8
9. Arrange informal assessment situations in science teaching.	1	2	3	4	5	6	7	8
10. Use oral questions at a variety of cognitive levels in science instruction.	1	2	3	4	5	6	7	8
11. Utilize assessment data on students in determining grades.	1	2	3	4	5	6	7	8
12. Design assignments that will provide for successful learning opportunities to groups of students with varied abilities and interests.	1	2	3	4	5	6	7	8
13. What other needs, relative to the diagnosis and evaluation of learners for science instruction, do you have? (Please list them below and rate each.)								
C. PLANNING SCIENCE INSTRUCTION								
14. Develop an instructional plan for a unit (e.g., six weeks) of science instruction.	1	2	3	4	5	6	7	8
15. Select appropriate instructional strategies for science instruction, based on stated learning outcomes.	1	2	3	4	5	6	7	8
16. Develop a lesson plan for a single class session.	1	2	3	4	5	6	7	8

Page 3

	Not Important 1	Little Importance 2	Moderately Important 3	Great Importance 4	No Need 5	Little Need 6	Moderate Need 7	Great Need 8
	IMPORTANCE				NEED			
17. Prepare and evaluate teacher-made instructional materials for science instruction.	1	2	3	4	5	6	7	8
18. Arrange the physical environment for science instruction.	1	2	3	4	5	6	7	8
19. What other needs, relative to planning science instruction, do you have? (Please list them below and rate each.)								
D. DELIVERING SCIENCE INSTRUCTION								
20. Motivate students to learn and practice science.	1	2	3	4	5	6	7	8
21. Encourage students to undertake projects, and be willing to assist and advise their efforts.	1	2	3	4	5	6	7	8
22. Present an interdisciplinary approach to science instruction.	1	2	3	4	5	6	7	8
23. Use an inquiry teaching strategy in teaching science, when appropriate.	1	2	3	4	5	6	7	8
24. Conduct a variety of science laboratory sessions.	1	2	3	4	5	6	7	8
25. Deliver a lecture/illustrated talk on a science topic.	1	2	3	4	5	6	7	8
26. Demonstrate major science concepts (e.g., cycle, energy-matter, change, equilibrium, field).	1	2	3	4	5	6	7	8

Page 4

	Not Important 1	Little Importance 2	Moderately Important 3	Great Importance 4	No Need 5	Little Need 6	Moderate Need 7	Great Need 8
	IMPORTANCE				NEED			
27. Demonstrate major science process skills (e.g., classifying, controlling variables, designing experiments, analyzing data, etc.)	1	2	3	4	5	6	7	8
28. Demonstrate major science manipulative skills (e.g., measuring, handling materials, maintaining materials, etc.).	1	2	3	4	5	6	7	8
29. Plan and direct a variety of field trips in teaching science.	1	2	3	4	5	6	7	8
30. Locate and use local areas for field trips.	1	2	3	4	5	6	7	8
31. Employ teaching strategies that clarify the values of science (e.g., demanding verification, respecting logic, considering consequences, etc.)	1	2	3	4	5	6	7	8
32. Employ individualized instructional strategies in teaching science.	1	2	3	4	5	6	7	8
33. Employ small group instructional strategies in teaching science.	1	2	3	4	5	6	7	8
34. Conduct group discussions/debates in teaching science.	1	2	3	4	5	6	7	8
35. Use a variety of audiovisual equipment to support science instruction.	1	2	3	4	5	6	7	8
36. Use computers/teaching machines to support science instruction.	1	2	3	4	5	6	7	8
37. Use library/media center to support science instruction.	1	2	3	4	5	6	7	8

Page 5

	Not Important 1	Little Importance 2	Moderately Important 3	Great Importance 4	No Need 5	Little Need 6	Moderate Need 7	Great Need 8
	IMPORTANCE				NEED			
38. Present a historical perspective in the teaching of science.	1	2	3	4	5	6	7	8
39. Employ teaching strategies that develop in students science process skills.	1	2	3	4	5	6	7	8
40. Employ teaching strategies that develop in students science manipulative skills.	1	2	3	4	5	6	7	8
41. What other needs, relative to delivering science instruction, do you have? (Please list them below and rate each.)								
E. MANAGING SCIENCE INSTRUCTION								
42. Manage a science instructional budget.	1	2	3	4	5	6	7	8
43. Provide for students' safety in the science laboratory.	1	2	3	4	5	6	7	8
44. Attend to students' physical, emotional, and social needs in science instruction.	1	2	3	4	5	6	7	8
45. Keep organized student records.	1	2	3	4	5	6	7	8
46. Communicate student science learning progress to the student, administrators, and parents.	1	2	3	4	5	6	7	8
47. Supervise a paraprofessional in the science classroom/laboratory (e.g., laboratory technician).	1	2	3	4	5	6	7	8

Page 6

	Not Important 1	Little Importance 2	Moderately Important 3	Great Importance 4	No Need 5	Little Need 6	Moderate Need 7	Great Need 8
	IMPORTANCE				NEED			
48. Involve students in the establishment of learning goals and in decision-making in order to minimize the need for disciplinary action in science instruction.	1	2	3	4	5	6	7	8
49. Evaluate one's own instructional effectiveness as a science teacher.	1	2	3	4	5	6	7	8
50. Evaluate and analyze the performance of other teachers in the different activities of the science curriculum.	1	2	3	4	5	6	7	8
51. Use a computer to manage maintain student records, create resource files, write and store assessment items, maintain inventories, and prepare grade and progress reports, etc.	1	2	3	4	5	6	7	8
52. What other needs, relative to managing science instruction, do you have? (Please list them below and rate each.)								
F. ADMINISTERING SCIENCE INSTRUCTIONAL FACILITIES AND EQUIPMENT								
53. Assist in the setting up of a laboratory supply order, storage and retrieval system.	1	2	3	4	5	6	7	8
54. Organize a science laboratory room.	1	2	3	4	5	6	7	8
55. Maintain science laboratory equipment.	1	2	3	4	5	6	7	8
56. Design and construct simple science laboratory equipment.	1	2	3	4	5	6	7	8

Page 7

	Not Important 1	Little Importance 2	Moderately Important 3	Great Importance 4	No Need 5	Little Need 6	Moderate Need 7	Great Need 8
	IMPORTANCE				NEED			
57. Select and evaluate science laboratory equipment for student use, based on stated criteria.	1	2	3	4	5	6	7	8
58. Identify sources of free and inexpensive science instructional materials.	1	2	3	4	5	6	7	8
59. Select and evaluate supportive materials (library books, films) for science instruction, based on stated criteria.	1	2	3	4	5	6	7	8
60. Maintain live organisms for science instruction.	1	2	3	4	5	6	7	8
61. What other needs, relative to facilities and equipment for science instruction, do you have? (Please list them below and rate each.)								
G. SCIENCE TEACHER SELF-IMPROVEMENT								
62. Update one's scientific knowledge in the field of teaching.	1	2	3	4	5	6	7	8
63. Incorporate the new knowledge appropriately into curriculum being taught.	1	2	3	4	5	6	7	8
64. Update one's scientific laboratory skills in the field of teaching.	1	2	3	4	5	6	7	8
65. Adapt suitable new methods of scientific laboratory skills for the classroom.	1	2	3	4	5	6	7	8

[illegible]

Page 9

I did not respond to the item(s) numbered _____, because I was not familiar with the activities described by them.

THANK YOU FOR COMPLETING THIS INSTRUMENT

The majority of the items in this questionnaire have been drawn from an instrument developed by Zurub (1982). Some of these items have been modified. Additional items were taken from Zeller and Watson (1974), the NSTA list of competencies (as reported by Simpson & Brown, 1977), and Chiappetta and Collette (1978a).



UNIVERSITY OF OREGON

أبريل ١٩٨٥ م .

الى حضرة مدرس العلوم المحترم

تحية طيبة وبعد ،

هأنني طالبة دكتوراة في جامعه أوريجون في الولايات المتحدة الأمريكية في
بعثة تعليمية من كلية البحريين الجامعية وأنني أحضر دراسة عن الاحتياجات
المهنية لمدرسي العلوم في المرحلة الثانوية في البحريين ، والغرض من هذه
الدراسة هو الحصول على بيانات تتعلق بعلاقة هذه بمنهج العلوم الجديد .

ان مساعدتك في اتمام المعلومات الديموغرافية والاستبيان مهمة لنجاح
هذه الدراسة .

كما ان المعلومات المتعلقة بانمام هذا الاستبيان مرفقة به .

أنني أؤكد لك انه لن يكون هناك ذكر لاسم المدرس أو المدرسة التي
تدرس فيها ، فجميع المعلومات سوف تكون سرية .

اذا كنت راعيا في الحصول على نسخة من نتيجة هذه الدراسة فالرجاء ذكر
ذلك في المكان المخصص وسوف أكون مسروره بارسالها لك في الوقت المناسب .

شكرا لك على تعاونك .

فاطمة خليفة مطر

معلومات ديموغرافية

١. الاسم (اختياري) : _____
٢. الجنس : _____ ذكر _____ انثى .
٣. عدد سنوات الخبرة في التدريس بما في ذلك السنة الحالية _____ سنوات .
٤. عدد سنوات الخبرة في تدريس العلوم بما في ذلك السنوات التي درست فيها _____ العلوم من ضمن المواد الأخرى التي قمت بتدريسها _____ سنوات .
٥. عدد الحصص التي تدرسها في الأسبوع في هذا العام : _____ حصص .
٦. عدد الحصص التي تدرس فيها العلوم في الأسبوع في هذا العام : _____ حصص .
٧. المؤهلات العلمية التي حصلت عليها ، الرجا' وضع علامة (/) بعدها مع ذكر مادة التخصص (مثال بشهادة البكالوريوس / أميا)

<u>الشهادة</u>	<u>مادة التخصص</u>
_____ - الثانوية العامة	_____
_____ - دبلوم معهد المعلمين أو المعلمات	_____
_____ - شهادة البكالوريوس	_____
_____ - دراسات عليا	_____
_____ - مؤهلات أخرى (نرجو التحديد) :	_____
_____	_____
_____	_____

٨. هل تضمنت دراساتك التخصص لـ دبلوم تربوي ؟

_____ نعم _____ لا

- ٢ -

٩. هل تقوم الآن بالدراسة من أجل الحصول على شهادة في العلوم (في تدريس العلوم) ؟

نعم — لا —

١٠. ضع دائرة حول المراحل الثانوية التي تدرس العلوم فيها وعدد الشعبة (مثال :
علمي ، أدبي ، تجاري ، علوم صحية الخ) بالإضافة إلى عدد الصفوف التي تدرسها . إذا كنت
تدرس صفوف أخرى أو مواد غير مذكورة فالرجاء إضافتها .

المادة	المرحلة الثانوية	الشعبة	عدد الصفوف التي تدرسها
أحياء	أول	_____	_____
	ثاني	_____	_____
	ثالث	_____	_____
كيمياء	أول	_____	_____
	ثاني	_____	_____
	ثالث	_____	_____
جولوجيا	أول	_____	_____
	ثاني	_____	_____
	ثالث	_____	_____
فيزياء	أول	_____	_____
	ثاني	_____	_____
	ثالث	_____	_____
مواد أخرى (الرجاء التحديد)	المرحلة	الشعبة	عدد الصفوف

١١. هل تريد الحصول على نسخة من نتائج هذه الدراسة ؟

نعم — لا —

- ٢ -

تعليمات الاسبيان - ١

تعليمات الاسبيان

- يتضمن هذا الاسبيان عبارات تصف نشاطات يقوم بها مدرس العلوم .
- ويجاب كل عبارة هناك مقياسين مدرجين .

يعني المقياس الأول بأهمية النشاط المنضم في كل عبارة لتدريس منهج العلوم الجديد .

ويقسم هذا المقياس الى الدرجات التالية :

١. هذا النشاط غير مهم .
٢. لهذا النشاط أهمية قليلة .
٣. لهذا النشاط أهمية متوسطة .
٤. لهذا النشاط أهمية كبيرة .

الرجاء الاستجابة لكل عبارة بوضع دائرة حول أحد الدرجات التي تصف مقدار الأهمية التي توكلها لكل نشاط لتدريس منهج العلوم الجديد .

يعني المقياس الثاني يحتاجك للمساعدة لكي تصبح فديرا في ممارسة النشاط المنضم في كل عبارة ، ويمكن أن تكون هذه المساعدة على هيئة دورات تدريبية أو عون شخصي أو دراسات عليا .

ويقسم المقياس الثاني الى الدرجات التالية :

٥. ليس لدى حاجة للمساعدة .
٦. لدى حاجة قليلة للمساعدة .
٧. لدى حاجة متوسطة للمساعدة .
٨. لدى حاجة كبيرة للمساعدة .

الرجاء الاستجابة لكل عبارة بوضع دائرة حول أحد الدرجات التي تمثل حاجتك للمساعدة .

- ٤ -

تعليمات الاستبيان - ٢

المثال الأول :

الأهمية	الحاجة
١ ٢ ٣ ٤	٥ ٦ ٧ ٨

استخدام طريقة تدريس تسمى اكتساب
المفهوم في تدريس العلوم

ان مدرس العلوم الذي استجاب الى العبارة المعروضة أعلاه شعر بأنه ليس هناك أهمية
لاستخدام طريقة التدريس هذه في تدريس منهج العلوم الجديد وان لديه حاجة قليلة
للمساعدة لكي يصبح فديرا في ممارسة طريقة التدريس هذه .

المثال الثاني :

الأهمية	الحاجة
١ ٢ ٣ ٤	٥ ٦ ٧ ٨

استعمال مولد (فان دي جرااف)
في تدريس الكهرباء .

ان مدرس العلوم الذي استجاب الى العبارة المدونة أعلاه شعر بأن هناك أهمية متوسطة
لاستخدام مولد (فان دي جرااف) لتدريس الكهرباء في منهج العلوم الجديد وان لديه
حاجة كبيرة للمساعدة لكي يصبح فديرا في معرفه كيفية استعماله .

الرجاء الاستجابة للمقياسين في العبارات الأربعة والسبعين التالية وذلك
بوضع دائرة حول أحد التدريجات في كل مقياس ، تأكد من انك قد وضعت دائرة حول
تدريجين ، مقدار الأهمية والحاجة للمساعدة . اذا لم تتمكن من الاستجابة لبعض
العبارات لأنها تتضمن نشاطات غير مألوفة لديك فالرجاء كتابه أرقام هذه العبارات
في نهاية الاستبيان .

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أهمية كبيرة متوسطة قليلة	أهمية متوسطة قليلة	أهمية كبيرة متوسطة قليلة	أهمية كبيرة متوسطة قليلة
٨	٧	٦	٥
٩ - استخدام طرق غير تقليدية لتقييم الطلاب فسي تدرّس العلوم .	٩	٩	٩
١٠ - استخدام أسئلة شفوية على مستويات عقلية مختلفة في تدريسي العلوم .	١٠	١٠	١٠
١١ - استخدام بيانات الطلاب التقييمية في تحديد الدرجات .	١١	١١	١١
١٢ - تصميم واجبات تمنع فرص تعليمية ناجحة للمجموعة من التلاميذ ذو استعدادات وميول مختلفة .	١٢	١٢	١٢

	أهمية كبيرة ٤	أهمية متوسطة ٣	أهمية قليلة ٢	غير مهم ١	الأهمية
لا حاجة ٥	حاجة قليلة ٦	حاجة متوسطة ٧	حاجة عالية ٨		١٢ - ما هي الحاجات الأخرى المتعلقة بتدريس وتقييم المتعلمين في تدريس العلوم تشرح بأنك بحاجة إليها (اكتب قائمة بها واعط تقديرا لكل منها) .
					د - نخطط تدريس العلوم
٩	٧	٦	٥	٤	١٤ - بطور خطة تدريسية لوحدة دراسية (مستعدة أمايخ) مثلا في تدريس العلوم .
٩	٧	٦	٥	٤	١٥ - اختيار استراتيجيات تعليمية مناسبة للتدريس العلوم بما ، على نتائج تعليمية متفق عليها .
٩	٧	٦	٥	٤	١٦ - وضع خطة تدريسية للحصة في تدريس العلوم .
٩	٧	٦	٥	٤	١٧ - اعداد وتقديم مواد تعليمية من قبل المعلم لتدريس العلوم .

أهمية كبيرة ٨	أهمية متوسطة ٧	أهمية قليلة ٦	لا حاجة ٥	أهمية كبيرة ٤	أهمية متوسطة ٣	أهمية قليلة ٢	غير مهم ١	الأهمية
٨	٧	٦	٥	٤	٣	٢	١	٢٤ - إدارة حصص علوم مخبرية مختلفــ

أهمية كبيرة ٨	أهمية متوسطة ٧	أهمية قليلة ٦	لا حاجة ٥	أهمية كبيرة ٤	أهمية متوسطة ٣	أهمية قليلة ٢	غير مهم ١	
الناحية				الأهمية				
٨	٧	٦	٥	٤	٣	٢	١	٢٠ - احسار وزيارة مناطق مطلية للرحلات العلمية
٨	٧	٦	٥	٤	٣	٢	١	٢١ - استخدام طرق تدريس توضح القيم العلمية كالسحق من صدق المعلومات ، احترام المنطق ، أخذ النتائج بعين الاعتبار .
٨	٧	٦	٥	٤	٣	٢	١	٢٢ - استخدام طريقة التعليم الفردي في تدريس العلوم .
٨	٧	٦	٥	٤	٣	٢	١	٢٣ - استخدام طريقة تقسيم الصف الى مجموعات صغيرة في تدريس العلوم .
٨	٧	٦	٥	٤	٣	٢	١	٢٤ - ادارة مناقشة جماعية في تدريس العلوم
٨	٧	٦	٥	٤	٣	٢	١	٢٥ - استخدام أجهزة معقدة بحرية مختلفة لتدعيم تدريس العلوم .

الأهمية				الأهمية			
أهمية كبيرة ٤	أهمية متوسطة ٣	أهمية قليلة ٢	غير مهم ١	أهمية كبيرة ٨	أهمية متوسطة ٧	أهمية قليلة ٦	لا حاجة ٥
و - إدارة الأدوات والوسائل التعليمية في تدريس العلوم							
٤	٣	٢	١	٨	٧	٦	٥
٥٢ - المساعدة في إعداد طلب مواد مختبرية باستخدام نظام الاسرئاد (الكشف عن المستهلكات والموجودات والمطلوبات) .							
٤	٣	٢	١	٨	٧	٦	٥
٥٤ - تنظيم غرفة مختبر العلوم							
٤	٣	٢	١	٨	٧	٦	٥
٥٥ - صيانة أدوات العلوم المختبرية							
٤	٣	٢	١	٨	٧	٦	٥
٥٦ - تصميم وبناء أدوات علوم مختبرية بسيطة							
٤	٣	٢	١	٨	٧	٦	٥
٥٧ - اختيار وتصميم أجهزة علوم مختبرية لاستخدامها الطلاب بناءً على أسس معينة							
٤	٣	٢	١	٨	٧	٦	٥
٥٨ - تحديد مصادر محاسبة ولغير نمونة للمواد المطلوبة في تعليم العلوم .							

غير مهم				الأهمية			
أهمية كبيرة ٤	أهمية متوسطة ٣	أهمية قليلة ٢	غير مهم ١	أهمية كبيرة ٨	أهمية متوسطة ٧	أهمية قليلة ٦	لا حاجة ٥
٤	٣	٢	١	٨	٧	٦	٥
٥٩ - اختيار مواد معينة (كتب وأقلام) لتدريس العلوم بناءً على أسس معينة .							
٤	٣	٢	١	٨	٧	٦	٥
٦٠ - المحافظة على عينات مية في تدريس العلوم							
٦١ - ما هي الحاحات الأخرى المتعلقة بإدارة الآلات والوسائل التعليمية في تدريس العلوم تشغى بانك بحاجة إليها (اكتب قائمة بها وأعط تقديرًا لكل منها) .							
٦٢ - للتطوير الذاتي لتعلم العلوم							
٤	٣	٢	١	٨	٧	٦	٥
٦٢ - اكتساب معلومات حديثة في حفل التدريس العلمي .							
٤	٣	٢	١	٨	٧	٦	٥
٦٢ - جمع هذه المعلومات الحديثة في المنهج بطريقه مناخية .							

٦ - المنهج الذاتي لمعلم العلوم

الأهمية				الأهمية			
أهمية كبيرة ٤	أهمية متوسطة ٣	أهمية قليلة ٢	غير مهم ١	أهمية كبيرة ٨	أهمية متوسطة ٧	أهمية قليلة ٦	لا حاجة ٥
٤	٣	٢	١	٨	٧	٦	٥
٦٤ - اكتساب مهارات مختبرية حديثة في حقل المدرسين العلمي .							
٤	٣	٢	١	٨	٧	٦	٥
٦٥ - تكشف هذه المهارات العلمية المختبرية الحديثة المناسبة بحيث يمكن استعمالها في الصف .							
٤	٣	٢	١	٨	٧	٦	٥
٦٦ - اكتساب معرفة علمية عميقة لاستخدام الاسمان للعلوم / التكنولوجيا .							
٤	٣	٢	١	٨	٧	٦	٥
٦٧ - اكتساب المعلومات العلمية الحديثة المتعلقة بالفرص المهنية المتوفرة لطلاب العلوم وتحل هذه المعلومات متوفرة للطلاب .							
٤	٣	٢	١	٨	٧	٦	٥
٦٨ - اكتساب معرفة علمية عميقة مرتبطة بغالبها اجتماعية .							

أهمية كبيرة ٤	أهمية متوسطة ٢	أهمية قليلة ٢	غير مهم ١	لا حاجة ٥	أهمية كبيرة ٨	أهمية متوسطة ٧	أهمية قليلة ٦	لا حاجة ٥
٤	٢	٢	١	٥	٨	٧	٦	٥
٤	٢	٢	١	٥	٨	٧	٦	٥
٤	٢	٢	١	٥	٨	٧	٦	٥
٤	٢	٢	١	٥	٨	٧	٦	٥
٤	٢	٢	١	٥	٨	٧	٦	٥

غير مهم	أهمية قليلة	أهمية متوسطة	أهمية كبيرة	لا حاجة	حاجة قليلة	حاجة متوسطة	حاجة كبيرة
١	٢	٣	٤	٥	٦	٧	٨
الأهمية				العامة			
٧٤ - ما هي الحاجات الأخرى المتعلقة بالتطوير الذاتي لمعلم العلوم تشعر بأنك بحاجة إليها (اكتب قائمة بها واعط تقديرا لكل منها) .							

لم أكتب إلى البنود التالية ————— لأن النشاطات المتضمنة بها غير مألوفة لدي .
شكرا على انهاء الاستبيان

بالية بنود هذا الاستبيان مأخوذة من استبيان صممه عبدالرحمن زعرب (١٩٨٢) وبعض هذه البنود قد حورت ، كما أن بنود إضافية أخذت من زلرو واتسون (١٩٧٤) ومن قائمة أعدت من قبل جمعية مدرسي العلوم الأمريكية وذكرها سيمسون و براون (١٩٧٧) ومن تشابهتها وكوليت (١٩٧٨) (١)

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