THE DEVELOPMENT OF SCIENCE EDUCATION AND CHEMISTRY TEACHING IN TAIWAN SECONDARY SCHOOLS (1945 - 1975)

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CURRICULUM STUDIORIUM

Mrs. Fu-yung Fan Chu was born in Shanghai, mainland China in 1924. She graduated from the Department of Chemistry, National Kweichow University in July 1947, with a degree of Bachelor of Science.

Mrs. Chu taught chemistry and physics in the high school of National Taiwan Normal University in Taipei from 1947 till 1971. She served as a member of the Junior High School Curriculum Revision Committee in 1967 and as a member of the Senior High School Curriculum Revision Committee in 1970. She also served as a member of the Textbook Compilation and Revision Committee during these years.

Since Mrs. Chu lived and taught in Taiwan more than twenty years, she has utilized her background, knowledge, and personal experiences in processing this study.

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INTRODUCTION

Following World War II, a great movement for reconstruction and development arose in many of the nations of the world. The development of science and technology offered the ingredients for better, richer, and healthier life for people in all nations.

Since the development of science and technology is by its nature a continuous dynamic process, it may take different courses in different countries. Each country has its own unique historical and cultural background, as well as its own social, political, and economic influences to inspire goals and to guide development. Each nation's particular goals, needs, resources, and experience help to determine its own plans for development.

The concept that a better educated citizenry is essential for the social and economic progress of a nation had not in the past been embraced in developing countries with the same enthusiam that it receives today. Most developing nations are now taking positive measures in the direction of accelerating educational development.

The purpose of this study is to present recent developments in the educational system in Taiwan. It will study the secondary school curriculum, and focus on the evolution of science in general and chemistry teaching in particular.

The content of this study consists of six chapters.

The first chapter serves as general introduction. It includes the historical and geographic background of Taiwan, its population, philosophy and aim of education.

The second chapter presents the current overall status of education in Taiwan. It concerns the organization of the educational system and discusses the progress which has been achieved in various aspects of education since 1945.

The third chapter deals with the many educational reforms in secondary education from 1945 to 1975, such as the Nine-Year Free Education Program, the revision of school curriculum, and the improvement of the elementary and secondary stages of general education both in quantity and quality.

The fourth chapter shifts from general secondary education to general science education at the secondary level. The development and improvement of science education, a survey of junior high school sciences, and innovations of senior high school sciences are presented.

The fifth chapter deals with the teaching of chemistry at both junior and senior high school levels. Chemistry curricula, teaching methods, and teachers' training program are discussed. This is followed by an analysis of both junior and senior chemistry teaching in recent years.

The final chapter is designed to summarize this study. It makes recommendations regarding future prospectives for science education in Taiwan. In addition, a stream of thought-patterns is formulated and an example given of how this concept can be applied to students scientific investigations.

Much of the data for this study was gathered from the Ministry of Education, the Provincial Department of Education, the National Science Council, the National Taiwan Normal University, and the China Year Book of Taiwan.

It is hoped that this study will contribute toward promoting a better understanding of the formidable task of educational development that has been in process in an effort to upgrade science instruction and chemistry teaching in the secondary schools of Taiwan.

CHAPTER 1

BACKGROUND OF THE STUDY

Education is one of the universal developments of individuals and nations. Future manpower will be dependent on well-educated men and women in many fields of human endeavor. Thus, education is a kind of investment which ensures an individual better social status later in life. It also contributes to the socio-economic growth for a nation.

In the last thirty years Taiwan had made the rapid progress in the field of economics and industry. This created a rapid expansion and development of school education. In order to facilitate the understanding of the current educational status of Taiwan, one must first attain some understanding of its historical background, its physical configuration and geographic position, its population, the cultural philosophy of its people, and the educational aims and policy of its government.

1 - 1 Historical Background

In Chinese history and culture, Taiwan is an integral part of continental China. Fossils found in archeological excavations in Western Taiwan and the Pescadores indicate that these islands were physically linked with the continent in prehistoric times.[1]

Before the coming of Chinese settlers in the 12th century, the aborigines of Taiwan were scattered along the coastal plains. They engaged in hunting, fishing and some farming. But not until the 17th century did large groups of Chinese begin to cross the Taiwan Straits. These Chinese from the mainland possessed a much higher agricultural technology than the aborigines and superimposed the Chinese culture upon the natives.

By 1624 when the Dutch invaded the island, the Chinese population was estimated at approximately 30,000.[2] The island then became an exporter of deer skin, deer meat, sugar and rice. The Dutch established a trading station, built fortresses and churches, welcomed Chinese laborers and imposed heavy taxes.

Two years after the arrival of the Dutch, the Spanish landed at Keelung in Northern Taiwan and occupied coastal areas in this region. The Spaniards were eventually driven out by the Dutch in 1641.

In 1661, Chen Cheng-kung, known to the western historians as Koxinga, remaining loyal to the Ming dynasty

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.132.
2. Ibid., p.133.

(1368-1644), took Taiwan from the Dutch and established a new base of operations against the Manchu invaders who established the Ching dynasty (1644-1911) on mainland China. For twenty years Koxinga's Formosa enjoyed a remarkable increase in its immigrant Chinese population and concomitent growth in agricultural production and continental strength. The spread of imported traditions followed naturally and soon Confucian ethics and education became a common feature of Taiwan's cultural landscape.

With the military submission of Koxinga's Formosa to the Ching dynasty in 1683, the island was placed under the provincial jurisdiction of Fu-Kien of mainland China. In 1887 the Ching dynasty realized the economic and political importance of Taiwan to the mainland, and made it a province of China. It then had a population of 2,545,731 according to the census undertaken by the first Governor Liu Ming-Chuan in 1893.[1]

In 1895, the treaty of Shimonoseki ended the Sino-Japanese War and among other concessions, ceded Taiwan to Japan. For the next fifty years it was developed as a colonial dependency of Japan and was sent much needed rice, sugar, fruits and resources to Japan. This time, however, the population throughout remained predominantly Chinese and the

1. Formosa Today. edited by Mark Mancall, Frederick A. Praeger Publisher, N.Y. London, 1964, pp.45-53.

quarter of a million Japanese settlers represented less than ten percent of the total population. During the fifty years of Japanese occupation, there were more than one hundred uprisings against Japanese rule. Although the Japanese were quick to respond to the economic and social challenges in Taiwan, they were noticeably tardy in answering the educational needs of the Chinese. Whereas, Japanese youth on the island enjoyed an unrestricted universal education, Chinese youth were subject to restrictive quotas at all levels of the educational system.[1]

At the end of the second World War, the Potsdam Declaration of July 1945 declared that the terms of the Cairo Declaration should be carried out. As a result of the Japanese surrender to The Allies, Taiwan was restored to the Republic of China on October 25, 1945 and was administered as one of the provinces of the Republic of China.[2] When the Chinese Communists over-threw the Chinese Nationalists on the mainland and established the Peoples' Republic of China, Taiwan became the last foot-hold of the Nationalists. From 1949 onwards, Taiwan has existed as an independent administration under the government of the Chinese Nationalists.

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.53.
2. Ibid., p.134.

1 - 2 Physical Configuration and Geographic Position

1-2-1 Location

Taiwan (Formosa) is an island off the southeast coast of mainland China with an area of 35,961 square kilometers (about 14,000 square miles). It is less than half the size of Scotland or the state of Maine (U.S.A.). Shaped like a tobacco leaf, it is 394 kilometers long and 144 kilometers broad at its widest point.[1]

On the island, the Central Monutain Range occupies almost half of the island, forming a ridge of high mountains with a length of 270 kilometers from north to south, and with an average height of 1,740 meters (5,000 feet). The relief on the east along the Pacific is very hilly and uneven while the relief off the west coast is quite level. This gives Taiwan a larger proportion of useful arable land than either Japan or the Philippines. In terms of human needs for food and raw materials, this coastal plain is of the greatest importance. It contains the area of densest population and most of the major cities.[2]

The map and the location of Taiwan island and the area of major land forms are shown in the following Figure 1 and Table 1, respectively.

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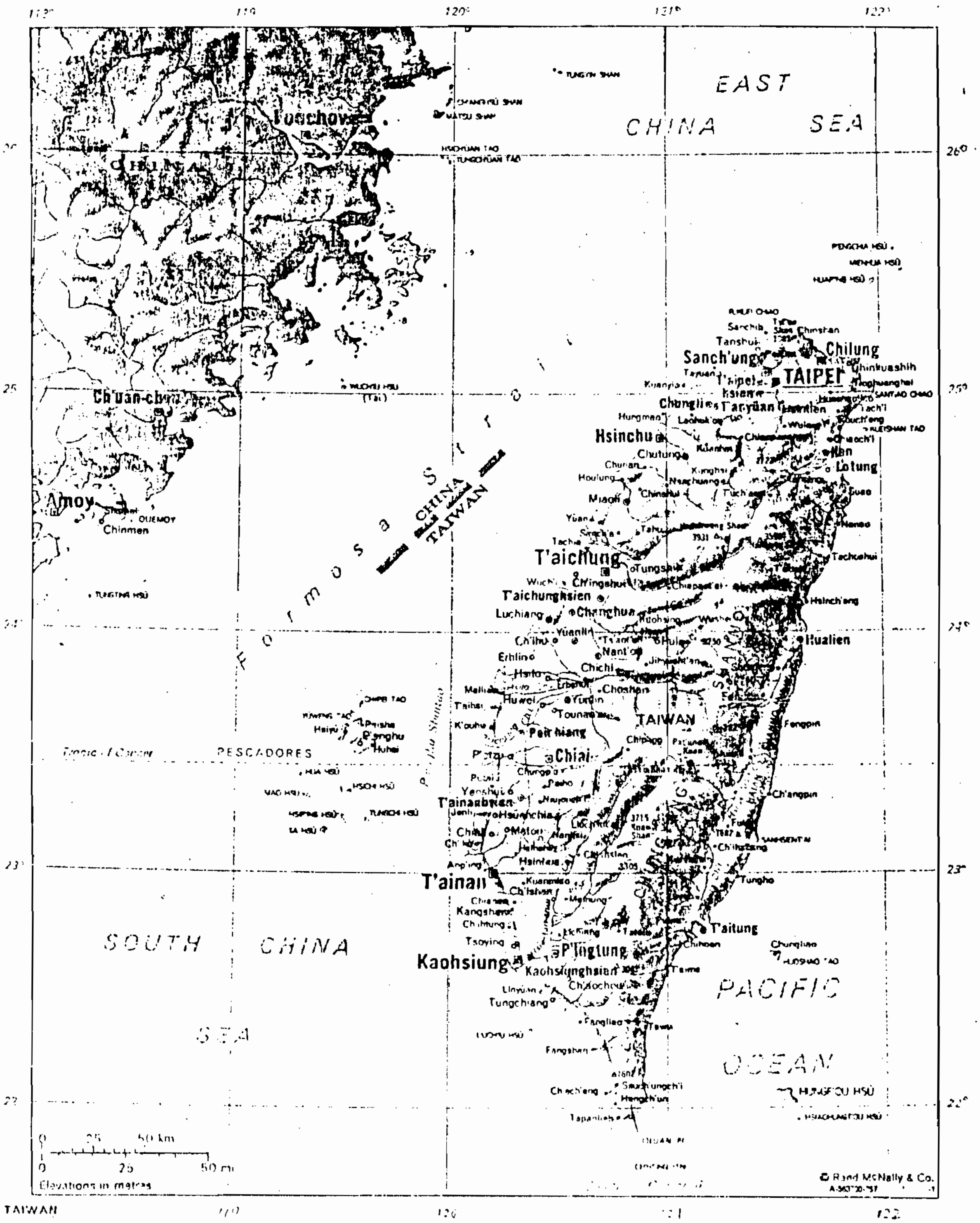
1. <u>China Year Book</u>, 1975, China Publishing Co., Taipei, Taiwan, p.134.
2. Ibid.,

Figure 1. The Map and the Location of Taiwan[1]



1. <u>The New Encyclopaedia Britannica</u>, vol.. 17, 1973-74, p996.

Table 1. The Area of Major Land Forms in Taiwan[1]

Land Form	Square Kilometers	Square Miles	%
Total	35,961	13,885	100.00
Mountains	22,835	8,817	63.5
Basalt and Mesa	108	42	0.30
Foothills	2,265	875	6.30
Terrace Tablelands	1,798	694	5.00
Alluvial Plains	8,739	3,374	24.30
Sandhills and Dunes	216	83	0.60

1-2-2 Climate

Lying between 21°45'25" and 25°37'53" north latitude and 119°18'3" and 122°6'25" east longitude, the island straddles the tropical and subtropical zones. The climate is subtropical in the north and tropical in the south.

The summer is long and humid, while the winter is short and usually mild. The mean monthly temperature rises to 20°C in April and remains at about 20°C until November. June to September brings the hottest weather, with mean monthly temperatures ranging from 25°C to 28°C. During cold

1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.137

months, the average temperature is about 15°C. In the coldest months, a thin layer of snow covers the peaks of the highest mountains. The temperature drops in direct proportion with the rise in altitude.

Rainfall is abundant. The mean annual rainfall is 2,580mm. with a maximum of more than 5,280mm. Thunder showers and typhoons often bring Taiwan heavy rainfall in summer months. With the violent winds and tremendous rainfall of typhoons, these tropical stroms often hit the island and cause heavy damage, espectially to crops.[1]

1-2-3 Agricultural Products

Agriculture, the leading element of Taiwan's economy, is concentrated mainly on the western plains (approximately 40 percent is arable). Warm currents creat a climate that makes vegetation abundant and permits two to three rice harvests a year. This climate is also favorable for the cultivation of other crops and tropical fruits, including sugar cane, sweet potatoes, bananas, oranges, papayas, watermelons and a large variety of vegetables.

Taiwan ha a forested area which is estimated at 1,969,500 hectares, or 55.1% of the total.[2]

Hogs are the major component of its people's live-

1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, pp.139-140.
2. Ibid., p.140.

stock. Chickens and ducks form the major portion of poultry production. Recently cattle and dairy production has increased under the technical and financial assistance of the government. The fishing industry is very active on the island. Because of warm currents, the continental shelf in the west and the Pacific Ocean coast in the east are good deep-sea fishing grounds. Fish migrate here and are caught in these waters. The Table 2 shows the major agricultural products in 1974.

Table 2. Major Agricultural Products in Taiwan[1]

Item	Products (Unit: M.T.)	Item	Products
Farm Crops:		Livestock:	
Rice	2,452,417	Hogs(slaughtered)	463,219 M.T.
Sweet potatoes	2,851,385	Cattles(")	4,880 M.T.
Peanuts	97,575	Poultry(dressed)	59,127,000 birds
Soybeans	67,181		
Corn	109,344	Milk	50,871 M.T.
Refined sugar	851,571	Fishery products	697,725 M.T.
Tea	24,269	Forestry:	
Tobacco	17,713	Timber	982,963,000 cubic meters
Pineapples	293,690		
Citrus fruits	350,000	Industrial raw material wood	205,321 cubic meters
Asparagus	105,296		
Mushrooms	61,699	Fuel wood	359,453,000 cubic meters
Onions	23,954		

Unit: M.T. = Metric Ton

1. China Year Book, 1975, China Publishing Co., Taipei, taiwan, p.189.

1-2-4 Industrial Growth[1]

Taiwan's economy suffered very heavy losses from Allied bombing in the closing stages of World War II. Almost all of the industrial establishments were destroyed. Restoration progressed rather slowly during the early postwar years. Since the government launched the First Four-Year Economic Development Plan, industry has undergone rapid development. From 1953 to 1972, industrial production grew at an average annual rate of 15.2 %, and it exceeded 20 % both in 1972 and 1973. The industrial growth of 1974 registered a decline of 1.5 % compared with that of the previous year. This result was attributable to the worldwide recession and energy crises which reduced demands for industrial products in the market. Table 3 shows the industrial production in 1974.

In 1949, a land reform program created the 'Land-to-the-Tiller' ideal. From 1953 to 1972, five Four-Year Economic Development Programs were carried out and these stimulated rapid growth of industry and agriculture. Grain crops have been sufficiently large to supply the needs of the population. Industry has continued to develop, both with domestic capital and foreign investment. Consequently Taiwan has become a self-supporting country and is an exporter of technical skills,

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, pp.192-194.

especially to developing countries in Asia and Africa.

Table 3. Principal Industrial Products in 1974 in Taiwan[1]

Unit: Doz. = Dozen
G.M.T. = Gross Ton (Volumetric Ton)
H.G. = Hectogram (about $3\frac{1}{2}$ ounces)
K.L. = Kiloliter
M^3 = Cubic Meter
M.T. = Metric Ton
NT$ = New Taiwan Dollar (about 0.025 of 1974 current U.S. Dollar)
Std. Case = Standard Case
Yd. = Yard

Item	Unit	Total Amount
Mining:		
Coal	M.T.	2,934,427
Crude oil	K.L.	209,975
Natural gas	1,000 M^3	1,586,701
Electrolytic copper	M.T.	9,859
Sulpher	M.T.	4,210
Salt	M.T.	362,809
Gold	H.G.	7,107
Heavy & Petrochemical:		
Paper & paper board	1,000 M^3	500
Rubber tires	1,000 set	1,104

Cont'd.

1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.195

Table 3. contd.

Item	Unit	Total Amount
Heavy & Petrochemical:		
Plastic shoes	1,000 pairs	197,037
Caustic soda	1,000 M.T.	182
PVC resin	1,000 M.T.	131
Aluminum ingots	1,000 M.T.	31,320
Sewing Machines	1,000 set	1,178
General machinery	1,000 M.T.	315
Textile machinery	1,000 M.T.	26
Agricultural machinery	Set	5,800
Electric fans	1,000 set	501
Air conditioner	Set	35,300
Refrigerators	1,000 set	413
Washing machines	1,000 set	157
TV Set	1,000 set	4,340
Recording machines	1,000 set	2,204
Electronic calculators	1,000 set	400
Electronic components & parts	NT$ Million	9,200
Automobiles	1,000 unit	28,000
Motor cycles	1,000 unit	304
Bicycles	1,000 unit	1,178
Ships or vessels	1,000 G.T.	306
Fluorescent lamps	1,000 unit	17,310

Table 3. contd.

Item	Unit	Total Amount
Light Industries:		
Canned pineapple	1,000 Std. case	2,670
Canned asparagus	1,000 Std. case	3,653
Canned mushrooms	1,000 Std. case	2,950
Wheat flour	M.T.	509,000
Monosodium glutamate	M.T.	19,097
Rayon staple	M.T.	44,761
Rayon filament	M.T.	3,104
Polyester staple	M.T.	73,576
Cotton Yarn	1,000 bales	750
Cotton fabrics	Million Yd.	864
Garments	1,000 Doz.	32,559
Plate glass	1,000 Std. case	1,960
Cement	1,000 M.T.	6,242
Plywood	Million cubic foot	3,762

1 - 3 Population

The 1940 census taken by the Japanese showed a population of 5,870,000, the majority being of Chinese descent. In 1946, the population was 6,090,000, about one percent of the total being made up of aborigines. With the defeat of the Nationalist Government on the mainland in 1949, there was a sizable immigration from parts of mainland China to Taiwan. As a result, by 1952 the population including immigrants from the mainland totaled 8,128,000. Table 4 shows the population and its growth in Taiwan at the end of 1974.[1]

The population density of Taiwan is one of the highest in the world. At the end of 1974, it was 440 persons per square kilometer: 388 persons for Taiwan province and 7,362 for Taipei city.[2]

About three-fifths of the population lives in cities and towns. Table 5 shows the population distribution by employment at the end of 1974. As of December 1974, about 12 percent of the population of Taiwan was between 15 to 19 years of age; less than 36 percent was under 15 years of age; less than one million was over the age of 60. (see Table 6).

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, pp.141-143.
2. Ibid., p.142.

Table 4. Population and Its Growth, Taiwan, As of End of 1974[1]

Year	Number(1,000 persons) Total	Male	Female	Index 1952=100	1956=100	Growth Rate(%)
1952	8,120	4,157	3,972	100	86.6	
1956	9,390	4,796	4,954	115.5	100	3.4
1959	10,431	5,336	5,095	128.3	111.1	3.9
1960	10,792	5,535	5,267	132.8	115.0	3.5
1961	11,149	5,715	5,434	137.2	118.8	3.3
1962	11,512	5,902	5,610	141.6	122.6	3.3
1963	11,884	6,098	5,786	146.2	126.6	3.2
1964	12,257	6,295	5,962	150.8	130.6	3.1
1965	12,628	6,471	6,137	155.4	134.5	3.0
1966	12,993	6,684	6,308	159.8	138.4	2.9
1967	13,297	6,841	6,445	163.6	141.6	2.3
1968	13,650	7,031	6,691	167.9	145.4	2.7
1969	14,335	7,554	6,781	176.4	152.7	3.0
1970	14,676	7,733	6,943	180.6	156.3	2.4
1971	14,995	7,895	7,100	184.5	159.7	2.2
1972	15,289	8,037	7,252	188.1	162.8	2.0
1973	15,564	8,175	7,390	191.5	165.8	1.8
1974	15,852	8,315	7,537	195.0	168.8	1.8

1. China Year Book, 1975, China Publishing Co., Taiwan, p.141

Table 5. Population Distribution by Employment in 1974[1]
(Age 15 and over)

Categories	Total	Percentage	
Grand total	6,236,675	100.00	
Primary Industry	2,309,009	37.02	
Secondary Industry	1,408,025	22.58	
Mining	59,512		0.95
Manufacturing	1,160,362		18.61
Construction	146,548		2.35
Electricity	41,603		0.67
Tertiary Industry	2,519,641	40.40	
Commerce	556,999		8.93
Transport	286,088		4.59
Services	1,674,778		26.85
Others	1,776		0.03

1. China year Book, 1975, China Publishing Co., Taiwan, p.144.

Table 6. Population Distribution by Age Group[1]

Age Group	Number in 1,000	Percentage
Under 5	1,792	11.3
5-9	1,930	12.2
10-14	2,011	12.7
15-19	1,898	11.9
20-24	1,673	10.6
25-29	1,058	6.7
30-34	948	5.9
35-39	871	5.5
40-44	838	5.3
45-49	812	5.1
50-54	645	4.1
55-59	462	2.9
60-64	381	2.4
65-69	250	1.6
70 & over	283	1.8
Total	15,852	100.0

1. China year Book, 1975, China Publishing Co., Taiwan, p.143.

A large proportion of the population of Taiwan is comparatively young, with approximately 36 percent under 15 years of age. The population of Taiwan in 1906 was about 3 million, however, by the end of 1974 it increased more than 5 times to 15.8 million. Its population density in 1974 was one of the highest in the world - 440 persons per square kilometer. Since the government advocated birth control and family planning policy in 1964, the growth rate of population has dropped yearly. The effectiveness of family planning is reflected in the dramatic reduction in the natural increase rate from 30.2 per 1,000 (birth rate 36.3, death rate 6.1) in 1963 to 19.0 (birth rate 23.8, death rate 4.8) in 1973.[1] The national objectives of the family planning program are:

1) to improve the quality of population,
2) to maintain population growth at a reasonable level,
3) to enable the people to enjoy a happy family life,
4) to meet socio-economic development needs of the country.

As to literacy of the people, statistics show that four-fifths of the people over 15 received normal education.[2]

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.302.
2. Ibid., p.143.

Table 7. Population Distribution by Education(age 15 & over)[1]

level of Education	Number(1000 persons)	Percentage(100%)
Advanced	711	7.0
Secondary	3,093	30.6
Elementary	4,244	41.9
Others	393	3.9
Illiterate	1,678	16.6

Education under the Nationalist government is concerned with language, therefore, people are now speaking mandarin as the principal language of Taiwan. However, it should be noted that several other Chinese dialects are still spoken.

Many kinds of religion have been introduced into Taiwan over the past 300 years. The Chinese brought Buddhism and Taoism with them. In 1622 the Dutch introduced Protestant Christainity; in 1624 the Spanish brought Roman Catholicism to the island; and later Japan introduced Shintoism. In addition, Confucianism has immensely influenced the Chinese people of Taiwan in ethics, morality, and academic thinking.[2]

1 - 4 Philosophy

Taiwan has common Chinese cultural roots.

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.143.
2. The New Encyclopeadia Britannica, Vol.17, p.998.

The term 'Ancient China' refers to the period from the earlist time of Chinese history to the unification of China in 221 B.C. by the Chin dynasty. It was in this period that China's greatest thinkers lived: Confucius (551-497 B.C.), Mencius (372-288 B.C.), Chang-tze, Mo-tze, and Hanfei-tze. This period laid the foundation of Chinese society and Chinese culture, charactering Chinese society as distinct from the Western World.

The political and ethical ideas of these philosophers concerning human relationships have greatly affected the peoples' way of thinking and family life in a society, concerned with the dealings between government and the governed. Filial piety of parents and homage to the emperor were the two great standards of personal and social life. Out of these grew the virtues of propriety, righteousness, obedience, faithfulness, modesty, charity, self-respect, and public-mindedness. There were eight steps to attain these virtues: objective investigation, acquisition of knowledge, sincerity of will, human-heartedness, cultivation of the person, proper family relationship, orderliness in the nation and peace and equality in the world. Confucianism, which advocates universal brotherhood, has exerted a strong influence on the national thinking.

Social progress was truly an enrichment of the traditional culture throughout thousands of years. The educational system had as its principal aim the selection and training og civil servants. The ruling bureaucracy was selected by a state system of examination. The content of instruction remained basically literary-philosophical in nature. Texts were committed to memory. A thorough knowledge of Confucian classics was required. Its general effect was to confine the mind and to train the memory.

In 1905, with the end of the Ching dynasty, the thousand-year-old examination system was abolished and in its place the principles of Western education were adopted. This was due to the growing influence of the Western world and Japan. It was natural for the Chinese to begin to see education as a means of national salvation. Education shifted in emphasis from the humanstic and historical to the scientific and technological. But the period of Chinese scientific activity did not begin until the first year of the Republic of China (1911). The older education reformers had only introduced a book knowledge of the sciences, without fully understanding their intellectual significance, without adequate equipment for laboratory work, or trained leaders to organize studies and research.

For three decades (1945-1975), the supreme target of education under the Nationalist Republic of China in Taiwan was the realization of the 'Three Principles of the People', the principles of Democracy, Nationalism, and

Livelihood, as espoused by Dr. Sun Yat-sen. The basic philosophy of a general education rested on the teachings of Dr. Sun Yat-sen and Confucius, to cultivate children and youths on eight national moral virtues, i.e., Loyalty, Filial Piety, Kindness, Love, Faith, Righteousness, Harmony, and Peace. But students had to be taught skills and technique to earn a living in order to improve the overall productive power of the people.

1 - 5 The Aim and Policy of Education

China has a long educational tradition and the people are known to favour learning and to respect scholars highly. One of the greatest aspirations of the Chinese is to educate themselves and their children. The educated Chinese believe that man must first cultivate himself to perfection, for only then can he cultivate his family, bring the same harmonious order to the state, and finally extend the same influence all over the world, with the ultimate hope of achieving universal peace and prosperity. This view has penetrated to the very foundations of the Chinese civilization and philosophy, and has become the ideal of Chinese education for centuries.

In Taiwan, the Chinese Nationalist government introduced legislation to modernize Chinese education: "In accordance with the Three Principles of the People, the purpose of Chinese education is to: 1) improve national living, 2) achieve mutual assistance, 3) develop national economic life, 4) prolong the life of the nation, so as to attain, by any means, the independence of the nation, democracy and a higher standard of living, and 5) advance to an ideal world where harmony and equality prevail."[1]

Based on the policy set forth in the Constitution of the Republic of China (see Appendix I),[2] education should stress national morality, Chinese cultural traditions, scientific knowledge and ability to work and to contribute to the community.

The Constitution stipulates that all citizens shall have equal opportunities to receive an education, and that a fixed amount of the budget for different levels of government must be spent on education.

This Constitution also stipulates that all children of school age between the ages of 6 to 12 shall receive free primary education. In 1968, this period was extended to nine years of continuous schooling in Taiwan, including primary education and three years of junior high school.

As a result of this extension, the government of Taiwan suspended the operation of all vocational junior high schools that previously recruited graduates from elementary schools.

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1. Education in the Republic of China, 1972, The Ministry of Education, Taipei, Taiwan, p.5.
2. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, pp.637-638.

In order to meet the current situation, the policies of education in Taiwan are programmed as follows:[1]

1) to enhance the development of national spirit and renaissance of Chinese culture,
2) to promote science development planning,
3) to raise the standards of college education,
4) to create technological colleges,
5) to continue nine-year universal free education,
6) to improve pedagogical education,
7) to encourage private citizens to set up educational organization,
8) to strengthen cultural institutions, such as museums, galleries, libraries, stadiums,
9) to promote physical education,
10) to guide cultural organizations to encourage literary activities, and
11) to promote cooperation in international culture.

1 - 6 Summary

This chapter has shown that Taiwan has many special qualities:

1) It is the heiress to a heritage of Chinese culture and civilization.

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, pp.96-97.

2) It endured a half century (1895-1945) of political and economic exploitation under the Japanese.

3) It has transformed itself from a predominantly agricultural economy to a high level of industrialization and has worked towards the goal of a self-sustaining economy through the process of progressive industrialization and improved agricultural production.

4) After World War II, Taiwan had an administrative base of Chinese Nationalists to support its developing efforts, and also a well-organized educational system. The basic value of democracy as a way of life constitute a workable philosophy upon which the school should build its goals. Much of the present emphasis upon the educational goals is due to concern over national survival.

5) The rapid post-war growth has made Taiwan the district with the highest population density in the world and the most critical problem in educational expansion is coping with the rapidly growing school-age population.

6) In a historical perspective, education has been held in high esteem, mainly because of the importance attached to learning Confucianism.

7) At the present moment (after 1975) the demand for education in the fields of science and technology is greater than ever, and at the same time, there is also an increasing awareness of spiritual education with the Chinese cultural heritage.

The development of education in Taiwan, therefore, is concerned with its historical and social background as well as with its over-all national goals.

CHAPTER 2

ORGANIZATION OF EDUCATIONAL SYSTEM
AND
EDUCATIONAL DEVELOPMENT

It is necessary to have exact knowledge of the educational conditions and trends in Taiwan in order to understand the educational development of this island. With this in mind, this chapter is designed to provide general educational information.

Firstly, the organization and functions of educational administration shall be presented. Education in Taiwan is administered by the Nationalist Government on three levels: the Central Ministry of Education, the Provincial Department of Education and the Local Bureau of Education.

Secondly, the school system in Taiwan is based upon the modern school system of the Republic of China. Regular education, special education and supplementary education shall be discussed accordingly.

Following World War II, several changes and a great deal of effort were devoted towards the expansion and the improvement of education in Taiwan. This includes educational expenditure, educational development at various levels and contemporary trends within educational development.

2 - 1 Educational Administration

Education in Taiwan is administered by government agencies on three levels: Central, Provincial, and Local.

According to the Constitution of the Republic of China in Taiwan,[1] the Central (National) government has the power to legislate and to administer national education. or may delegate this power of administration to the provincial governments. The provincial government, in turn, may delegate the power of legislation and administration to the local governments. The local government has the power of legislation and administration of local education.

On the national level, the Ministry of Education is in charge of policy-making and national educational development. On the provincial level, the Taiwan provincial government has a Department of Education, and each large municipality has a Bureau of Education with a status equal to the Department of Education. On the local level, the agency in charge is the Bureau of Education under the jurisdiction of the local government.

The organization and system of educational administration are as shown in Figure 2: System of Educational Administration.

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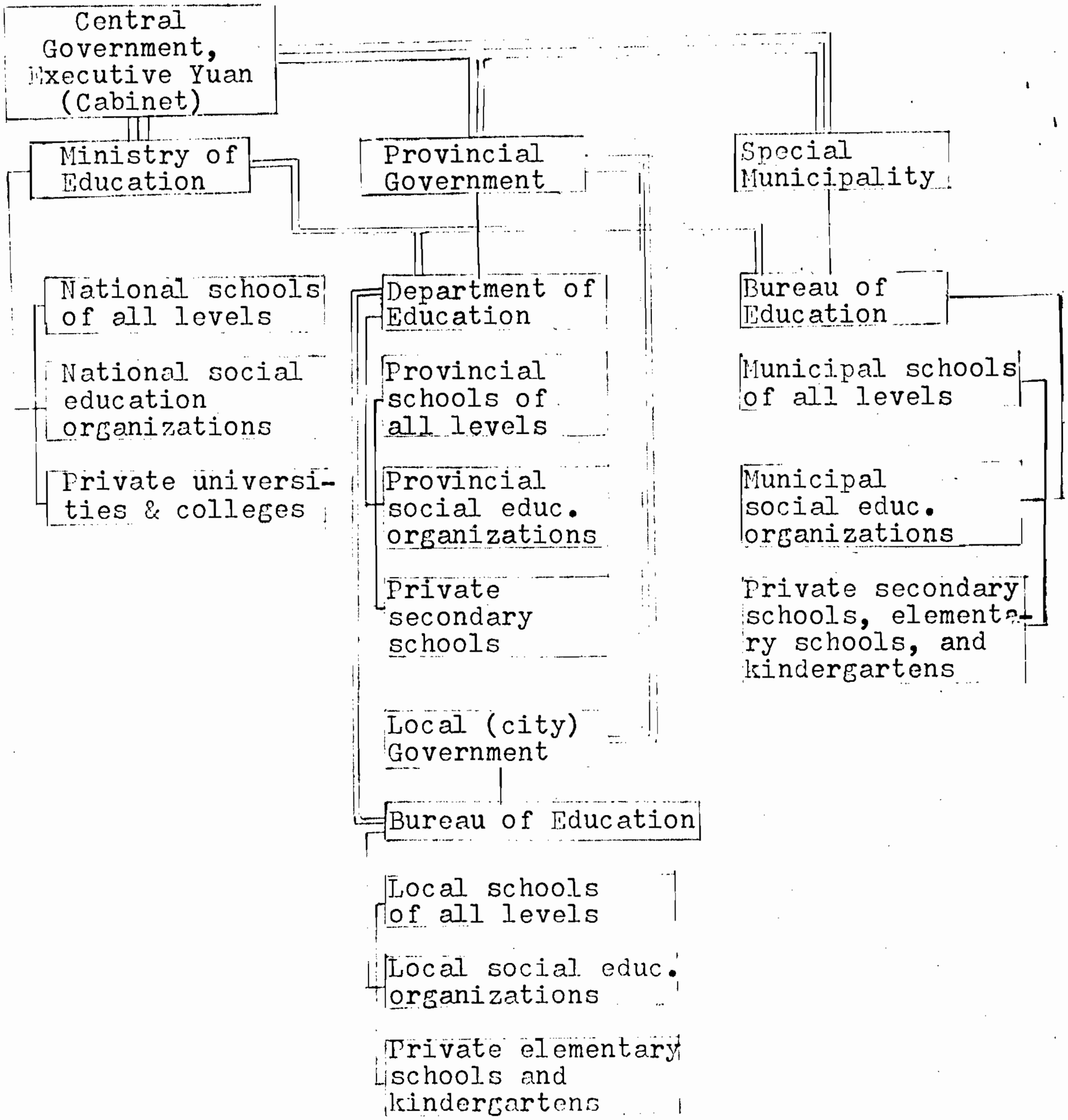
1. Education in the Republic of China, Ministry of Education, 1972, Taipei, Taiwan, p.8.

Figure 2. SYSTEM OF EDUCATIONAL ADMINISTRATION[1]



≡ Promulgating Laws and Allocating Budget.

= Establishment of Standards, Supervision and Grant-in-Aid.

— Control and Maintenance.

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1. Education in The Republic of China, Ministry of Educ. 1972 Taipei, Taiwan, p.9.

The organization and functions of educational administration on each level shall be described accordingly.

2-1-1 Ministry of Education

The Ministry of Education has six branches, namely Internal Units, Councils and Committees, Affiliated Units, Affiliated Schools, External Units, and Overseas Cultural Units. The main functions of the Ministry of Education are as follows:

1) Responsibility for administration of academic work, culture and education of the nation.

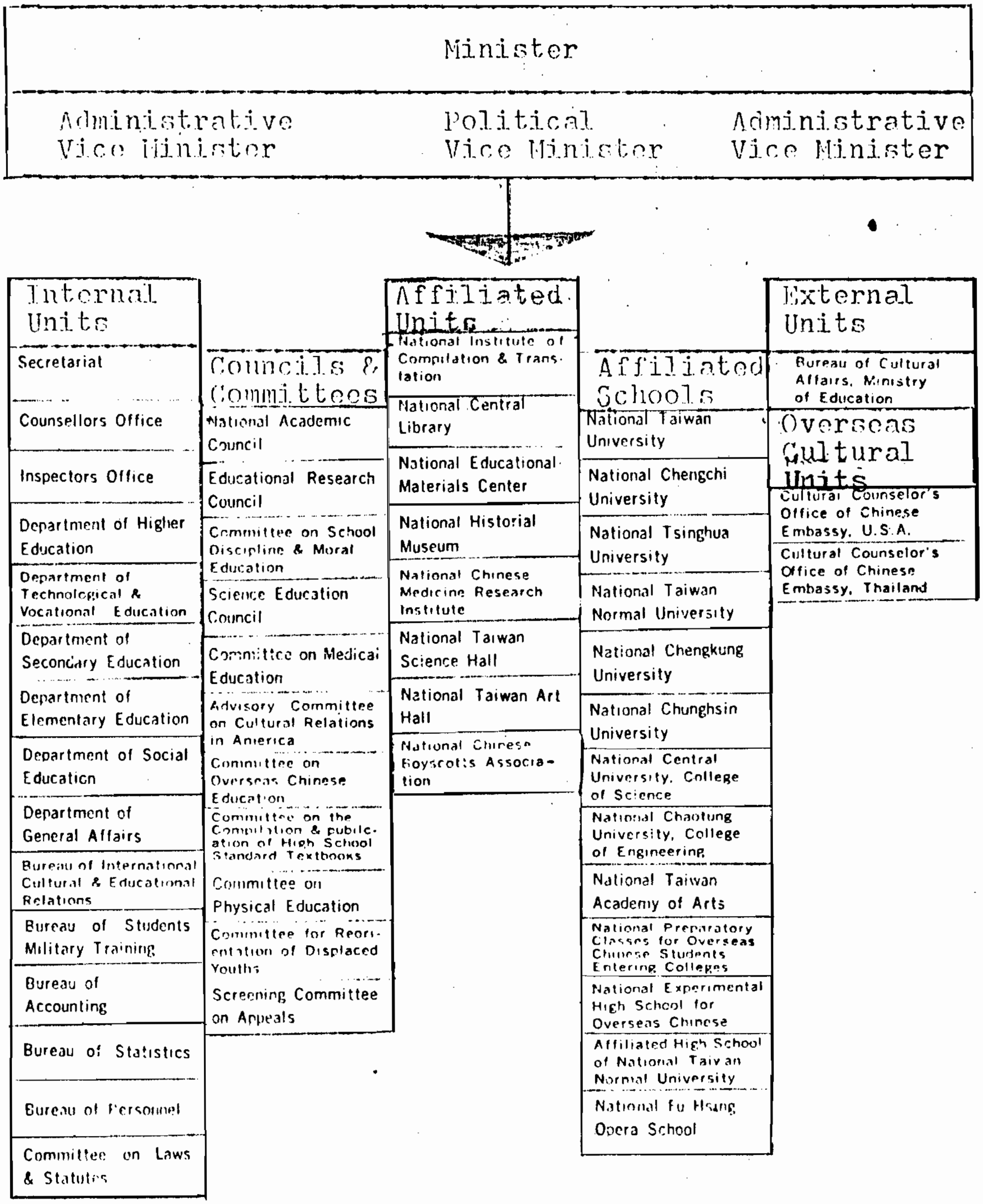
2) Instruction and supervision of the top local administrative officers regarding the execution of the power delegated by the Ministry.

3) Communication of budget estimates and draft bills to "Executive Yuan" (Cabinet).

4) Guidance, advice, and assistance to social educational activities and international activities.

The organization of the Ministry of Education is shown in Figure 3.

Figure 3. ORGANIZATION OF MINISTRY OF EDUCATION [1]

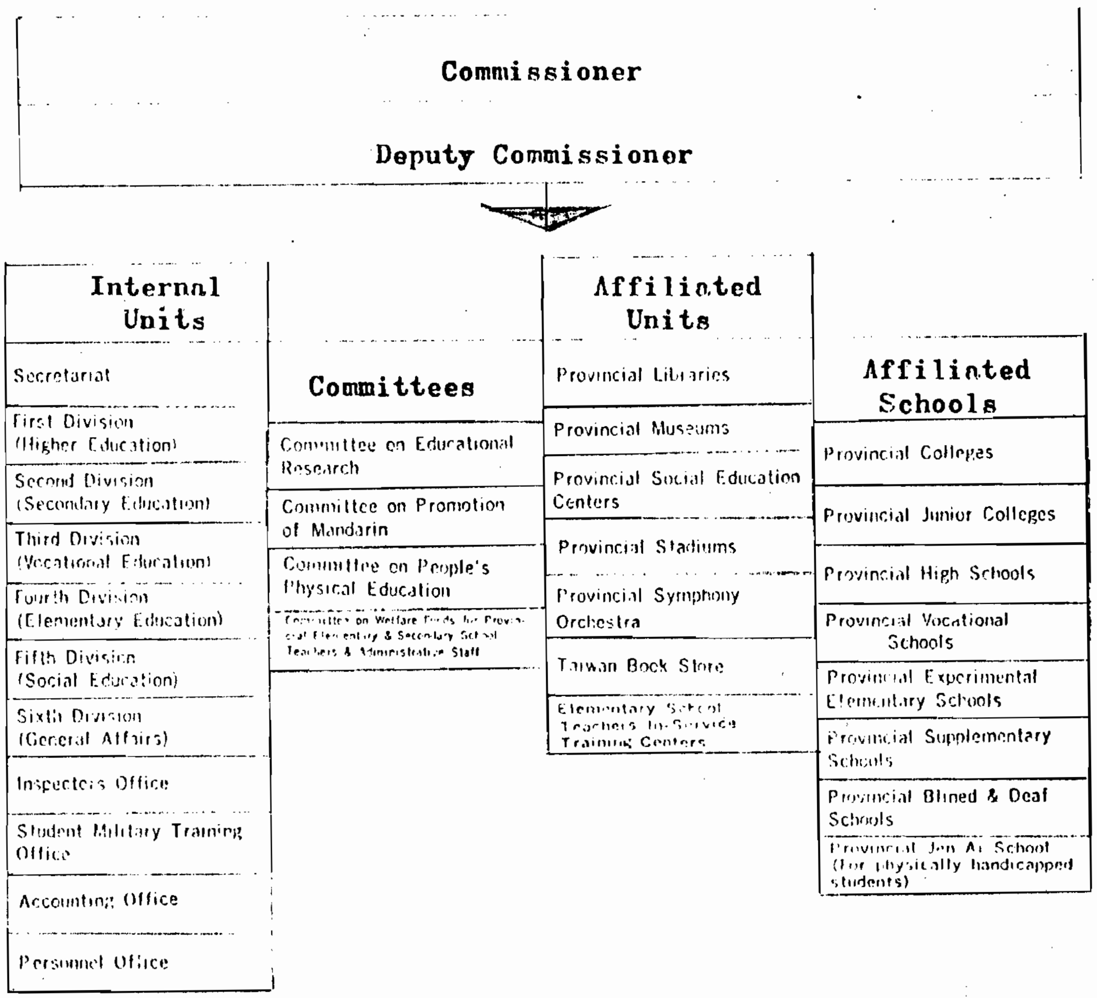


1. Education in the Republic of China, Ministry of Educ., 1972, Taipei, Taiwan, p.11.

2-1-2 Provincial Department of Education

The Provincial Department of Education has four branches: Internal Units, Committees, Affiliated Units and Affiliated Schools. The organization of the Department is as shown in Figure 4.

Figure 4. Organization of Taiwan Provincial Department of Education[1]



1. Education in the Republic of China, Ministry of Education, 1972, Taipei, Taiwan, p.12

The main functions of the Provincial Department of Education are as follows:

1) Responsibility for provincial academic and social education.

2) The supervision and guidance of educational and academic bodies in the province.

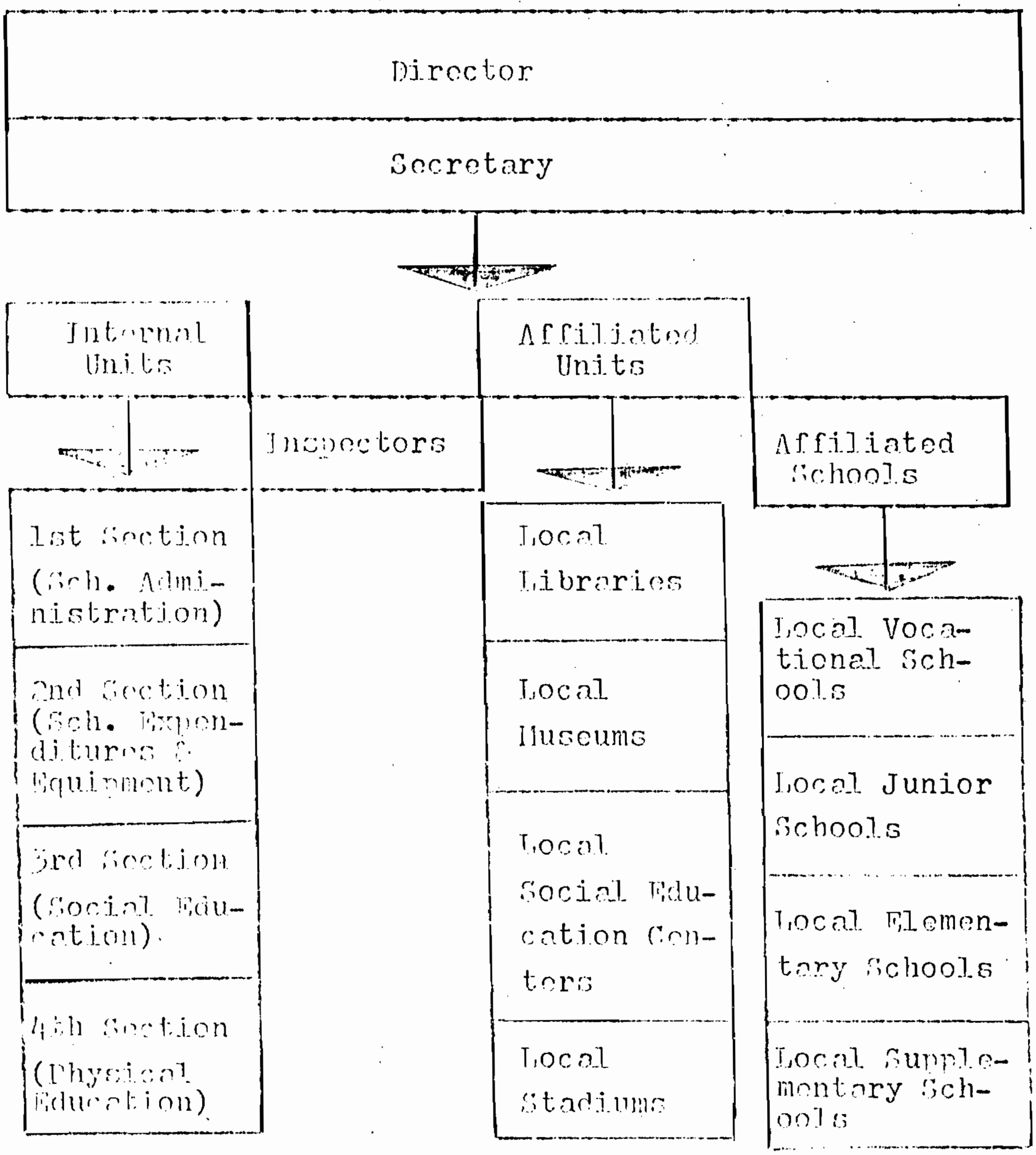
3) The planning and administration of public libraries, museums, and stadiums in the province and others.

2-1-3 Local Bureau of Education

There are four branches under the Local Bureau of Education: Internal Units, Inspectors, Affiliated Units, and Affiliated Schools to deal with the improvement and supervision of educational affairs in the locality.

The Internal Units include four departmental sections governing school administration, school expenditures and equipment, social education and physical education. The Affiliated Units control the planning and administration of cultural and social educational activities. All public junior high schools, elementary schools, and vocational schools are under the jurisdiction of the Local Bureau.

Figure 5. ORGANIZATION OF LOCAL BUREAU OF EDUCATION IN TAIWAN[1]

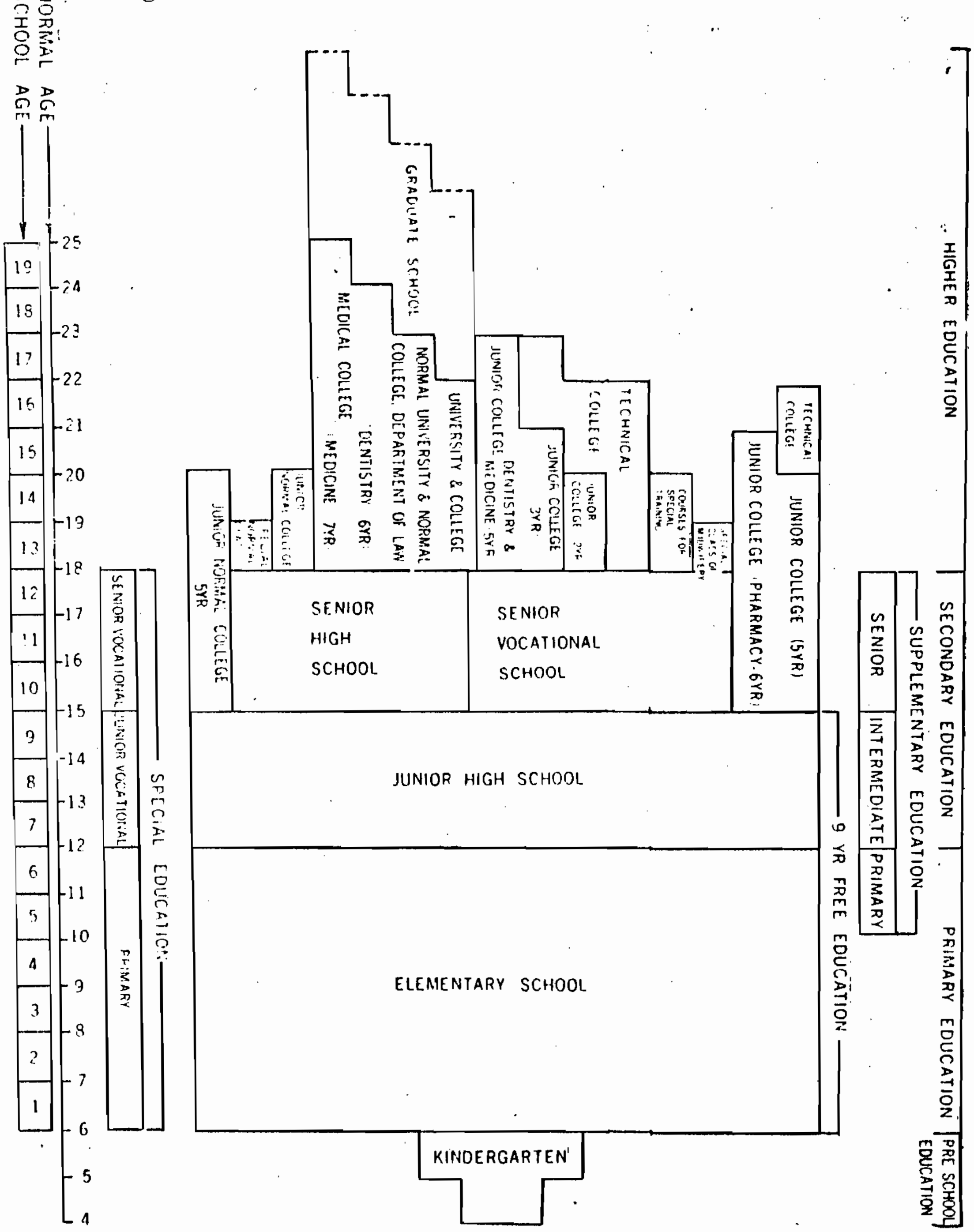


1. Education in the Republic of China, Ministry of Educ., 1972, Taipei, Taiwan, p.12.

2 - 2 School System

Since World War II the school system in Taiwan has been based on the modern system of the Republic of China.

Figure 6. THE CURRENT SCHOOL SYSTEM[1]



1. Educational Statistics of the Republic of China, Ministry of Educ., 1976, Taipei, Taiwan, p.2.

2-2-1 Regular Education

From the beginning of kindergarten to the completion of university, the overall length of time required covers a minimum period of twenty-two school years (as shown in Figure 6). Two years are spent in kindergarten which takes care of children in the 4-6 year age group. Elementary schools educate pupils in the 6-12 year age group. Three-year junior high schools follow elementary schools for the age group of 12-15 years. The second stage of secondary education which includes three-year senior high schools, three-year senior vocational schools, and five-year junior colleges, is open to junior high school graduates upon the passing of an entrance examination. Graduates from senior high schools, senior vocational schools and supplementary high schools passing the joint college-university entrance examination held by the Ministry of Education are permitted to enroll in three-year colleges, or four-year universities (except in the case of the Teacher Training Program which requires five years, and in the case of medical studies which require six or seven school years). There is a minimum of two years required for a Master's degree and a minimum of two years leading to the Doctoral degree in graduate schools. In the case of evening students, one additional school year is required to complete the higher educational program.

2-2-2 Special Education

Special education in Taiwan includes education for blind, deaf, and physically handicapped children. Its purposes are to provide them with educational opportunities that will allow these students to reach their maximum potential, and to lead an active life. There are kindergarten, elementary, junior vocational, senior vocational, and vocational supplementary schools, established to coordinate with the social welfare policy.

2-2-3 Supplementary Education

Supplementary education includes supplementary schools and short term training programs. Supplementary schools can be divided into two types: general and vocational. Each type is further divided into three levels--junior, intermediate, and senior--according to the courses of study offered or to the nature of the instructional material used. As far as academic standards are concerned, each level is equivalent to specific grades in the regular school system.

Supplementary Education	Regular Education
Junior level	Grade 5-6
Intermediate level	Grade 7-9
Senior level	Grade 10-12

Anyone can attend supplementary schools regardless of age or sex. The schools are mainly open to young working people. They may enjoy the same status as graduates of regular schools of the same level, if they can successfully pass a government examination. For these reasons, supplementary schools have been able to meet the needs of young people and have grown rapidly in recent years.

Short-term training programs are of two categories: general and vocational. The general program offers Chinese, mathematics, and civic education for illiterate adults. The vocational program mainly provides training in practical skills and languages. Some examples are abacus, bookkeeping, electrical maintenance and repair, printing, cooking, sewing, handcrafts, gardening, interior decoration, and foreign languages. All courses are of practical use in the daily life of students.

In addition, supplementary education for laborers, military personnel on active service, cooresspondence schools, radio and television courses, and reformatory education for juvenile delinquents are conducted by educational agencies.

2 - 3 Educational Developments of the period 1945-1975

The chief characteristic of these three decades was a rapidly increasing complexity of economic and social conditions. Within this period, the economy grew rapidly and the population continued to increase. Taiwan developed with unprecedented life and vitality, and increased in resource development, in technology and in culture. These radical changes in the structure and way of life of the population called for an elaboration of new social controls. It is natural that education must serve as the fundamental social control in a democratic society. These changes came about through a persistent effort towards educational expansion to meet the challenges of a modern world.

In Taiwan, the expansion of education has been most notable at all levels under the impact of the expanding social and economic demands for manpower and the increasing individual demands resulting from the rising level of the nation's living and culture. In recent years the rising trend in the percentage of the national income devoted to education has achieved a comparatively broad quantitative expansion of education.

2-3-1 Educational Expenditure

One of the most important aspects in educational planning is the financing of projected development. Educational expenditures lay the foundation of both the quantitative and qualitative development of education.

1) Sources of Support of Education

In Taiwan, public education is financed through tax revenues, tuition fees and private contributions to educational services. As prescribed in the National Constitution "Expenditure for educational programs, scientific studies, and cultural activities may not be less than 15 % of the national, 25 % of the provincial, and 35 % of the city and county budgets." (see Appendix I). Since the transfer of the Central Government to Taiwan, the lion's share of the national budget has been used for defence. Consequently, the stipulated percentage of national educational expenditure has not been attained.

The government of various levels in 1975 spent a total of NT$16,737,000,000 (US$440,200,000) on public education.[1] The distribution is shown in Table 8 on page 41.

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.243.

Table 8. Distribution of Educational Expenditure by Governmental Levels in 1975[1]

Governmental Levels	Amounts		%
	New Taiwan $	US$ Equivalent	
The Central Govt.	NT$1,631,000,000	US$43,000,000	9.7
Taiwan Prov. Govt.	NT$3,413,000,000	US$90,000,000	20.4
Taipei City Govt.	NT$2,504,000,000	US$66,000,000	14.9
Cities & Counties Govt.	NT$8,800,000,000	US$231,000,000	52.6
Villages & Towns	NT$ 389,000,000	US$10,200,000	2.4
Total	NT$16,737,000,000	US$440,200,000	100.0

As illustrated by the above table, the Central Government commits significantly less funds toward education than its official claim. As a result, the greater part of educational expenditures is derived from local sources.

2) National Income and Expenditure

Educational development is reflected in the expenditure devoted to education in relation to total national income. To analyse educational expenditure more precisely, the private educational expenditure must be take into consideration along with the public educational expenditure. The trend in the percentage distribution of expenditure for both public and private education of the Gross National Product (GNP) is shown in Table 9.

1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.243.

Table 9. Total Educational Expenditure As Percentage of GNP in 1951-1975[1]

Unit: NT$1,000

Year	GNP	Total Educational Expenditure					
		Total	% to GNP	Public	% to GNP	Private	% to GNP
1951	12,315,000	213,082	1.73	213,082	1.73	-	-
1955	30,088,000	673,263	2.24	673,263	2.24	-	-
1960	62,561,000	1,671,962	2.67	1,470,169	2.35	201,793	0.32
1965	112,867,000	3,959,628	4.54	3,234,989	3.71	724,639	0.84
1970	226,368,000	11,236,766	4.96	9,065,121	4.00	2,171,645	0.96
1975	524,478,000	21,064,636	4.02	16,737,000	3.19	4,327,636	0.85

Figures in Table 9 show that the Gross National Product has grown since 1951 and the portion devoted to education has increased from 1.73% in 1951 to 4.02% in 1975. In 1951, the government spent NT$213,082,000 on educational expenditure, about 9.93% of total government expenditure; while in 1975 the government educational expenditure amounted NT$21,064,636,000, about 15.06% of the total government budget.[2] The total educational expenditure in 1975 about 98 times greater than that in 1951. These vast increases in expenditures are the result of the interaction of many factors: a rapid increase in school population, an extension of the legal compulsory education from 6 to 9 years, and increased jurisdictional responsibilities assigned to schools by the Ministry of Education. Also, this has resulted in the introduction of many

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1. Educational Statistics of The ROC, 1976, Ministry of Education, Taipei, Taiwan, p.46.
2. Ibid., p.47.

new types of studies and activities, such as the expansion and revision of the curriculum, the development of vocational education, the establishment of continuing education, and a great number of other new projects. In addition, three other causes should be added: a steady rise in the educational and professional qualification demanded of school teachers, which has necessitated an increase in the salaries paid, a similar rise in building and equipment standards, and the depreciation of the purchasing power of the dollar.

More recently, however, the emphasis has returned to education as an efficient investment in the development of human resources. The reason is that the nation can control its own economic development, and that the prosperity and safety of the nation depend upon "Keeping up in the economic race". Consequently, the need to invest in education has been seen more clearly in the technological field. Japan and the United States, for example, have been prosperous since the Second World War, largely due to the good return on their investment in education. Though the dividends of investment in education can not be realized immediately, its impact on the development of intellectual resource, perseverance, courage, alertness, farsightedness, on the ability to organize and on the supply of brains and skills to sustain the economic productivity, is vital in enriching the nation. From this point of view, education is a national investment and continuing investment in education shall clearly be necessary.

2-3-2 Educational Development at Various Levels

1) Pre-school Education

The purpose of pre-school education is to properly take care of children not yet of school age and to provide them with opportunities for good habit formation so as to be able to adapt themselves to group living. Children between the ages of three and four are admitted to the nursery and those between four and six to the kindergarten. Before the 1960s, pre-school education in Taiwan was not well developed. There existed only 28 independent kindergartens with 17,111 pupils in the 1950-51 school year. With the advent of social stability, economic prosperity, small families, and more gainfully employed married women, there developed an increasing need for families to send their children to kindergartens. In the 1975-76 school year there were 487 private and 275 public kindergartens, with a total of 117,990 pupils. The total number of pupils in kindergartens has increased by about 5.9 times as compared with that of 1950-51.[1]

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1. Educational Statistics of the Republic of China, 1976, Ministry of Education, pp.13-14.

2) Elementary Education

Elementary education is the foundation for all other formal education mainly operated by local governments. Some are operated by private interests. Children are admitted at the six of age. The schooling period is six years. This compulsory education applies to every citizen. The emphasis is on moral and physical culture, in order to imbue the citizens with the principles of ethical and life education, and to bring up healthy and sound citizens. In 1950 there were only 1,231 elementary schools with 906,950 pupils. With the steady increase in population during the ensuing years, the number of elementary schools and their capacities also increased with the years. In 1975, the number of schools had increased to 2,376 and that of pupils to 2,364,961 registering a rise, respectively, of 93% and 161% over the corresponding figures of 1950.[1]

3) Secondary Education

Taking the school system as a whole, secondary education is usually considered as the link between elementary and higher education. The duration of secondary school life is six years. In Taiwan, secondary education includes general

1. Educational Statistics of the ROC, 1976, Ministry of Education, Taipei, Taiwan, p.14

high schools, normal schools, and vocational schools. In 1950, there were 213 secondary schools of which 128 were high schools, 8 normal schools and 77 vocational schools, with a total of 120,036 students. In the 1975-76 school year, the number of schools increased to 977 including 800 high schools and 177 vocational schools. This represented an increase of 4.58 times over the 1950 figure. As to the number of students, it also had increased to a total of 1,505,993. The rate of increase is 12.5 times as compared with that of 1950.[1]

4) Higher Education

The purpose of higher education is to offer advanced studies and to prepare specialists for their respective professions. In recent years, as a result of rapid economic development and higher standards of living, people desire that their children receive better and more advanced education. Consequently, higher education has grown rapidly in rate scope. In 1950, there were 7 institutes including 1 university and 6 colleges with an enrollment of 6,665. In the 1975-76 academic year, the number of institutes rose to a record of 101, of which 9 were universities, 16 were colleges, and 76 were junior colleges, with a total of 156 affiliated research institutes. This represented an increase of 13.4 times during

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1. Educational Statistics of the ROC, 1976, Ministry of Educ., Taipei, Taiwan, pp.15-16.

the interval. As to the number of students, it rose to a total of 289,435, marking an increase of 42.43 times.[1]

5) Special Education

In the 1950-51 school year there were only 2 schools for the blind and the deaf with a total of 384 pupils. The number of such schools in the 1975-76 school year rose to six, of which three took in only the blind, and three only the deaf. They had a total of 2,641 pupils. In addition, an experimental school for the physically handicapped had a students body of 207.[2]

6) Supplementary Education

In the 1950-51 school year there were 5 general supplementary schools with 1,122 students. The number of such schools in the 1975-76 school year rose to 167, with a total of 39,604 students, marking an increase of 34.30 times during the interval. As to vocational supplementary schools, in the 1950-51 school year there were 18 vocational with 2,659 students. In the 1975-76 school year, the number of schools increased to 150, with a total of 128,178 students, an increase of 47.21 times as compared with the number of students in 1950.[3]

1. Educational Statistics of the ROC, 1976, M. of Educ., pp.140.
2. Ibid., pp.166-167.
3. Ibid., pp.174-175.

The following table gives the summary of school conditions in 1950 and 1975 and reflects the development in a span of twenty-five years.

Table 10. The Growth of Schools, Teachers, and Enrollments, 1950 and 1975[1]

Year	1950	1975
A. Number of school in total	1,504	4,540
No. of univ., coll., & graduate sch.,	7	101
No. of Secondary schools	213	977
No. of elementary schools	1,231	2,376
No. of kindergartens	28	762
No. of special schools	2	7
No. of supplementary schools	23	317
B. Teacher / student ratio	1:36.35	1:30.90
C. Studentsper class	51.75	47.62
D. Student/population ratio	140:1000	274:1000
E. School attendance for the age group of 6-12 years	79.98	99.29
F. % changes in student attendance at various levels:		
Elementary schools	86%	53.16%
Secondary schools	11.4%	33.85%
Colleges & universities	0.6%	6.51%
Other educational institutions	2%	6.48%

1. This table was derived from data given in the Educational Statistics of the ROC, 1976, Taipei, Taiwan, pp.12-13.

In the twenty five years (1950-1975) education in Taiwan has grown rapidly in the following aspects:

A. There is a great increase in the number of schools which has gone up nearly 202%.

B. The rate of increase in the number of teachers is greater than the rate of increase in the number of students. This is to the greater benefit of the students. They can receive more attention and better instruction.

C. The comparison of average numbers of students per class shows a decrease in class size, thus enhancing learning efficiency.

D. The student/population ratio in the past twenty five years has increased, almost doubled. This reflects that the people recognize the value of good education.

E. Elementary level school attendance in 1950 was 79.98% as compared with 99.29% in 1975. This indicates that the percentage of school-going children between ages six and twelve has grown to near capacity.

F. School attendance in both secondary and college levels has also increased. This shows that the educational system at all levels has grown in size. The growth was outpaced more and more by increase in population, and demonstrated the prosperity and stability of the society. It also indicates that for young people wishing to pursue further studies, the opportunity has become universally available.

2-3-3 Contemporary Trends in Educational Development

Education, a product of the existing environment, is not only created to meet the needs of human life but is also modified by changes in the social structure and the needs of national development. The educational system in Taiwan is being adjusted and improved as required by society to keep education up-to-date with new world trends by absorbing new knowledge, concepts, and methods, so that educational renovation can lead to an over-all renovation of the society. In order to meet the current situation, the following measures are being implemented:[1]

1) Strengthening national spirit education

Since education is the foundation of the national reconsctruction and is rooted in the fostering of national spirit, Committees for the Promotion of National Spirit education have been set up in schools at various levels. They are responsible for the development and implementation of patriotic education for all students in order to develop the confidence of self-strengthening and self-consciousness.

2) Balanced quantitative development

Since 1968 when the nine-year Basic Education Program was put into effect, the quantitative educational development has accelerated. To meet the shortage of educated and basic-level manpower, basic education needs to be improved continually.

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1. Education in Taiwan Province, ROC, 1974, Taiwan Provincial Government, Taiwan, pp.10-14.

At the post-secondary level, an overall quantitative improvement project will be undertaken to meet specific social needs.

3) Development of science education

The Provincial Department of Education has suggested a plan for the accelerated preparation and training of science teachers, and for the revision of science curriculum at the elementary and secondary levels. The expansion of school facilities and the improvement of laboratory teaching methods are also under way.

4) Development of vocational education

During recent years, as a result of a rapid development in business and industry, the pattern of supply and demand of manpower has undergone a dramatic change. More technicians are required in business and industry. The educational system should meet the needs of society and make appropriate adjustments. From 1968 on, the number of students at the upper secondary school level has been regulated on the basis of a plan to accelerate the development of vocational education. In 1967, the number of students in senior vocational schools and senior high schools was fixed at a ratio of four to six. According to this plan, the ratio will be seven to three by 1980. The number of students among the agricultural, technical, commercial, fishery, medical, and home economics fields must be adjusted.According to estimates in Manpower Development

Plan, the number of future graduates from the technical and fishery vocational schools should be increased to meet the demand.

5) Strengthening cooperative education

Education is a national enterprise. It relies upon large-scale investment by the government. Recently, most countries in the world are encouraging the private sector to enter the educational field and to share with government the responsibility for education. Cooperative education is a way of utilizing local resources to complement all sorts of professional, technical and industrial arts training. In this way it is not only designated to prepare technicians and specialists needed in industry, but also to promote the development of in-school education. At present, cooperative education programs are being conducted in public junior high schools,.senior vocational schools and technical junior colleges.

In order to implement the "Plan to help the Needy" initiated by the Provincial Government, the Department of Education is conducting school-centered vocational training for poor people, to assist and guide them in becoming fully employed. The purpose is to increase the quantity of basic-level skilled labor contributing to economic development.

6) Promotion of educational experimentation

In recent years, some major educational experiments have been conducted:

A. Elementary school: Integrating teaching of blind children into regular elementary schools; experiments in education of the retarded; experiments in special education for artistically and musically gifted; experiments in large unit and team-teaching; and experiments in teaching of national phonetic symbols.

B. Public junior high school: Experimental improvement of internal organization; curriculum experiments; experiments in the economic value of strengthening vocational education; the experimental integration of the entire nine-year free education; and experiments in the education of retarded children.

C. Senior high school: Experiments in science education.

D. Senior agricultural school: Experiments in planting on graveled lands, extension of agricultural mechanization, and in the industrialization of the livestock industry.

E. Senior technical school: Experimentation in cooperative education and in the application of 'Ladder' teaching methods.

Hereafter, all schools will conduct a variety of experiments in curriculum and teaching methods, in order to meet social needs and to upgrade the educational standard.

2 - 4 Summary

The educational system and development in Taiwan may be summarized as follows:

1) Education in Taiwan is administered by government agencies through three levels: Central, Provincial, and Local. The Central Government is the exclusive policy making agency and has the power to legislate and administer the national educational activities and system.

2) The school system adopted a 6-3-3-4 structure, and since 1968 compulsory education has increased from six years to nine years of schooling.

3) The scope and functions of educational activities, mainly include:

A. Academic disciplines.

B. Social education, special education and supplementary education.

C. Planning and administration of libraries, museums, stadiums and cultural displays.

4) The expenditures for educational programs, scientific studies, and cultural activities may not be less than 15% of the national budget, 25% of the provincial budget, and 35% of the local budget. The ratio of the total amount of educational expenditures to the Gross National Product is approximately 4:100 plus.

5) Education in Taiwan has developed rapidly in the last three decades. The number of schools, teachers, school attendance, and student/population ratio have increased. The average number of students per class, however, has decreased.

6) Contemporary trends in educational development in Taiwan are:

A. Strengthening of national spirit education

B. Balancing of quantitative development

C. Development of science education

D. Development of vocational education

E. Strengthening of cooperative education

F. Promotion of educational experimentation

CHAPTER 3

SECONDARY EDUCATION AND HIGH SCHOOL CURRICULUM

The purpose of this chapter is to discuss the significant phases of development in secondary education and high school curriculum within the past three decades from 1945 to 1975. Secondary education in Taiwan has undergone changes of great significance during the past ten years. These changes involved the complete reform of the school system and the revision of high school curriculum. In the quantitative aspect, there has been a remarkable increase in the number of schools and student enrollment. In the qualitative aspect, important modifications in the character of education have been provided progressively.

Initially, this chapter will examine the changes which occurred in the secondary schools and in student enrollment. It will then present the secondary school curriculum and the factors affecting curriculum change and revision. The chapter will conclude with a summary of significant changes which occurred in the educational system of Taiwan from 1945 through 1975.

3 - 1 Schools, Enrollments and Changes

The most significant fact in the development of education in Taiwan during the past quarter of a century is the remarkable growth of secondary schools and the great increase in the number of students. A general idea of the development of secondary schools since 1950 may be gained from figures for schools reporting to the Ministry of Education. Such figures are presented in Table 11.

Table 11. Number of Secondary Schools and Enrollments From 1950 to 1975[1]

School Year		Senior & Junior	Senior	Junior	Total No. of Sec. Sch.	No. of Students
	Total	94	9	110	213	120,036
1950	High sch.	62	-	66	128	79,948
	Normal sch.	-	8	-	8	5,651
	Voc. sch.	32	1	44	77	34,437
	Total	218	33	112	368	317,200
1960	High sch.	138	1	105	244	232,156
	Normal sch.	-	10	-	10	7,244
	Voc. sch.	80	22	7	109	77,800
	Total	96	236	553	885	1,154,589
1970	High sch.	93	92	553	738	977,960
	Normal sch.	-	1	-	1	924
	Voc. sch.	3	143	-	146	175,905
	Total	88	284	605	977	1,505,993
1975	High sch.	88	107	605	800	1,221,538
	Voc. sch.	-	177	-	177	284,455

1. Educational Statistics of the ROC., 1976, the Ministry of Education, Taipei, Taiwan, pp.89-91.

From 1950 to 1975 (the latest year for which comparable figures are available) the number of junior high schools increased from 110 to 605, the number of senior high schools from 9 to 284, and the total number of secondary schools (high schools and vocational schools) increased from 213 to 977. These figures show that the number of secondary schools increased more than four times in twenty-five years.

Even more striking and significant is the great increase in enrollment at the secondary school level. In 1950, the student enrollment in secondary schools was 120,036. In 1975, the figure for enrollment was 1,505,993. These figures indicate that the number of pupils in secondary schools increased more than eleven times from 1950 to 1975.

The reasons for this remarkable development are clear. First of all, implementation of the Nine-year Free Education Program in 1968 was of great significance. For the 1968 school year, Taiwan was divided into 429 school districts and in each district one school was established. In 1950, there were 101,015 elementary school graduates, of which 31.99% (32,319) enrolled in the junior high schools after passing entrance examination. In 1968, there were 269,299 of 360,683 graduates, about 74.66% enrolled in the junior high schools without taking entrance examination. In 1975, however, 367,742 of 408,316 graduates (about 90.06%) enrolled in the lower secondary schools. This increase indicates that the percentage of enrollment of elementary school graduates in the junior high school doubled in 1968 and tripled in 1975.[1]

Secondly, since the implementation of the Nine-year Free Education Program, public senior high schools have been administered only by the provincial government. Former public middle schools terminated their junior high departments and became senior high schools. Private high schools were changed to senior high schools or senior vocational schools. Some vocational schools were converted to comprehensive schools. After the reform, senior high schools grew steadily both in the number of schools and in student population. In order to provide greater opportunities for continuing education for public junior high schools graduates, this expansion was coordinated with similar development in vocational education. In this way, the increase in quantity in secondary schools was planned and adjusted yearly.[2]

Thirdly, the aims of the educational reform were not only to achieve an increase in years of schooling, but also to equalize the educational opportunities across the island, and to reorganize the educational content. In accordance with these stated aims, a series of projects have been continuously implemented, such as:

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1. Educational Statistics of the ROC, 1976, the Ministry of Education, Taipei, Taiwan, p.55.
2. Education in Taiwan Province, Dept. of Educ., Taiwan Provincial Govt., Taichung, Taiwan, 1974, pp.41-56.

1) Reducing the size of school districts,
2) Increasing the number of classes and schools,
3) Raising teachers' qualifications,
4) Adapting the teaching materials to individual differences,
5) Experimental studies in school curriculum,
6) Improvement of teaching materials and methods,
7) Promotion of guidance services,
8) Strengthening of vocational education, and
9) An expansion of school facilities.[1]

Through these projects, the secondary school increasingly met the demands of Taiwan society.

Fourthly, the senior high schools in Taiwan placed more emphasis upon education in the academic disciplines in order to provide advanced studies to their students. Throughout their three years of lower secondary education, the graduates are in a position to choose whether to pursue academic or vocational programs at the upper secondary level. In 1950, there were 23,114 junior high graduates of which approximately 61.8% (14,187) were enrolled in the upper secondary schools after passing an entrance examination. The majority of these students chose academic education. In 1975, however, there were 202,414 of 301,833 junior high school graduates (about 67.06) enrolled in the upper secondary

1. Education in Taiwan Province, Taiwan Provincial Department of Education, Taichung, Taiwan, 1974, pp.41-56.

schools.[1] Since 1970 the enrollment in senior vocational schools has shown a considerable increase, resulting mainly from the expansion and development of local industry. The comparison of enrollment is shown in Table 12.

Table 12. Percentage of Enrollment in Senior High Schools and Vocational High Schools[2]

School Year	Senior H.S. Enrollment	Vocational H.S. Enrollment	Total
1970-71	50.41 %	49.50 %	100 %
1971-72	48.95 %	51.05 %	100 %
1972-73	47.27 %	52.73 %	100 %
1973-74	45.14 %	54.86 %	100 %
1974-75	41.99 %	58.01 %	100 %
1975-76	39.61 %	60.39 %	100 %

The traditional conception of the Chinese people was in favor of granting the official careers to those who could pass through higher education. People looked down upon merchants and craftsmen. Youngsters and their families were therefore anxious to get the best education possible. This situation restricted the development of vocational education for many years. Because of the rapid growth of industry in recent years, vocational school graduates had no difficulties

1. Educational Statistics of the ROC, 1976, the Ministry of Education, Taipei, Taiwan, p.54.
2. Ibid., pp.102-105.

in finding employment. Since then, there are more students who prefer to choose vocational education even if they are accepted by the academic senior high school. This predilection to choose vocational education is a significant change in the social conception toward vocational education. It means that new and diversified demands have been made on the secondary school. It also means that pupils now attending secondary schools constitute a far more heterogeneous body in capacity, economic or social status, and educational needs than the secondary school clientele before 1950.

Since 1967 the scope of secondary education has been broadened by the junior college movement. There are two kinds of junior colleges established in Taiwan. The three-year junior college accepts the graduates from the senior high schools. The five-year junior college is a newly developed institution which is a hybrid of senior high school and college. These institutions provide an integrated education primarily for technological training. During the past ten years the junior colleges have grown rapidly and have made a great contribution to economic development.

The upward extension by the junior college education has been due to several factors, among which the most significant are:

1) A great increase in the number of persons desiring and deserving an education beyond high school,

2) The consequential overcrowding of universities,

3) The demand for facilities of higher education in the local community,

4) A need for upgrading the qualifications of the elementary school teacher,

5) The demand for more qualified technical workers,

6) Changing conception of the functions of secondary and collegiate education.

The following table shows the development in junior college education in the years between 1966-76.

Table 13. Development in Junior College Education[1]

School Year	No. of Junior College	No. of Pupils	Pupil Index
1966-67	48	45,000	100
1967-68	57	60,739	135
1968-69	63	76,696	170
1969-70	69	93,709	208
1970-71	70	106,187	235
1971-72	73	117,131	260
1972-73	76	136,236	302
1973-74	76	145,471	323
1974-75	76	147,796	328
1975-76	76	148,805	330

1. Education Statistics of the ROC, 1976, the Ministry of Education, Taipei, Taiwan, pp.120-121.

3 - 2 Program and Curriculum

The qualitative development of secondary education was as significant as the quantitative development as already outlined during the past three decades in Taiwan. One of the most important factors determining the quality of education was the curriculum. Since the end of the Second World War, a great movement of school curriculum reform has been in progress elsewhere. In Taiwan, as a result of accelerated changes in political, economic and social development, all curricula were revised to meet the needs of both individual and community. Educational facilities and teaching materials were also improved for effective learning.

3-2-1 Factors Affecting Curriculum Change

In Taiwan, as elsewhere, curriculum revision was accepted as a continuing process. There were a number of factors affecting curriculum change.

1) Traditionally, the value regarding the importance of education has provided strong popular support for curriculum change.

2) People in Taiwan have the unchanging belief of the democratic way of life. Democracy is built upon the promise

that society is composed of individuals free to explore the truth. The concept of an open society is conductive to experimentation into ways of improving the curriculum.

3) The Japanese colonial educational system was abolished in 1945. In its place was the equality of educational opportunities for everyone. In 1968, educational reform was extended from a six-year free education program to a nine-year program. Subsequently, curriculum for free education was reorganized.

4) Change in society has long served as an agent for curriculum change. Curriculum is subject to change when the needs and desires of society change. In past decades, rapid economic development had been the national prime objective. In order to supply the trained manpower necessary to achieve the economic aims, curriculum planning should be closely coordinated with the economic development.

5) The knowledge explosion was also an important factor that affected curriculum change. The extension of secondary school programs including non-academic studies, significant changes in science and technology, and the development of educational psychology and teaching materials have broadened the scope of the school's curriculum.

These factors mentioned above were the prime forces which influenced curriculum change and improvement in Taiwan.

3-2-2 Curriculum Revision

All of the school's curricula in Taiwan are centrally standarized and designated by the Ministry of Education. Dr. Sun Yat-Sen's "Three Principles of the People" are the supreme guiding principles for Chinese education. In essence, they are ethics, democracy, and science. In the spiritual sense, they are freedom, equality, and universal love. Guided by these principles, curriculum aims at educating people, reforming society and developing Chinese culture.[1]

When the Nationalist Government moved to Taiwan, the educational system was carried out exactly the same way as it on the China Mainland. As a matter of fact, the first curriculum provision in 1945 was based upon the curriculum provision which was promulgated on the mainland in 1940. In order to meet the requirement of different times and situations along with rapid scientific and technological progress the school's curricula were changed at regular intervals to meet needs of children and adolescents. The choice of subjects to be taught and the time allocation differed considerably from one time period to another. Subjects and total weekly hours in three years for both junior and senior high schools from 1945 to the 1970's are shown in Table 14 and Table 15.

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1. Education in Taiwan Province, ROC., Dept. of Education, Taiwan Provincial Government, 1974, p.3.

Table 14. SUBJECTS AND TOTAL SCHOOL HOURS PER WEEK IN THREE-YEAR OF THE SENIOR HIGH SCHOOL CURRICULUM FROM 1945 TO 1971[1]

No. of Revision / Subject	(I)1945 SSP[2]	(I)1945 NSP[3]	(II)1948	(III)1952	(IV)1955	(V)1962 SSP	(V)1962 NSP	(VI)1964 SSP	(VI)1964 NSP	(VII)1971 SSP	(VII)1971 NSP	Year Course	Hrs/Wk
Three Principle of the People	-	-	-	4	4	4	4	4	4				
Civics & Moral Educ.	6	6	4	8	8	8	8	8	8	12	12	3	2
Chinese Literature	34	26	30	30	30	36	32	36	32	40	32	3	5-7
Foreign Language(Eng.)	36	32	30	30	26	36	32	36	32	40	32	3	5-7
History	12	12	8	8	8	12	8	12	8	8	8	2	2-7
Geography	12	12	8	8	8	12	8	12	8	8	8	2	2-3
History of Culture	-	-	-	-	-	4	-	4	-	4	-	1	2-3
Political Geography	-	-	-	-	-	4	-	4	-	4	-	1	2
Mathematics	20	28	24	24	24	24	30	24	30	24	32	3	4-6
Physics	8	10	10	10	10	6	12	6	12	6	12	1	3-6
Chemistry	8	10	10	10	8	6	12	6	10	6	12	1	3-6
Biology	12	6	6	6	6	6	6	8	8	6	6	1	3
Minerology	2	2	-	-	-	-	-	-	-	-	-	1	1
Earth Science	-	-	-	-	-	-	-	-	-	-	4	1	2
Physical Education	12	12	12	12	12	12	12	12	12	12	12	3	2
Fine Arts	4	4	4	4	4	4	4	4	4	4	4	2	1
Music	4	4	4	4	4	4	4	4	4	4	4	2	1
Handcrafts	4	4	6	6	6	-	-	-	-	-	-	2	1-2
Industrial Arts	-	-	-	-	-	8	8	8	8	8	8	2	2
Military Training (Nursing for girls)	18	18	-	18	18	12	12	12	12	12	12	3	3
Electives	-	-	12	12	12	8-18	10-20	8-18	10-20	8-14	8-16	2	

1. The Table is derived from Senior High School Curriculum Standard, 1971, Ministry of Education, Cheng-Chung Book Co., Taipei, Taiwan, pp. 359-417.

2. SSP: Social Science Program.

3. NSP: Natural Science Program.

Table 15. SUBJECTS AND TOTAL SCHOOL HOURS PER WEEK IN THREE-YEAR OF THE JUNIOR HIGH SCHOOL CURRICULUM FROM 1945 TO 1971[1]

Subjects / No. of Revision	(I)1945	(II)1948	(III)1952	(IV)1955	(V)1962	(VI)1968	Year Course	Hours/we
Civics	6	6	6	12	12	12	3	2
Moral Education	-	-	6					
Chinese	32	30	30	36	36	36	3	5-6
History	12	12	12	12	12	10	3	2
Geography	12	10	10	10	10	10	3	2
English	*[2]	20	20	20	20	12-18	3	2-3
Mathematics	22	18	18	18	18	18-24	3	3-4
Chemistry	6	-	-	-	-	8	2	2
Physics	6	-	-	-	-	8	2	2
General Science	8	6	6	6	6	6	1	3
Physics-Chemistry	-	16	16	12	12	-	2	3
Handcrafts	12	9	9	9	-	-		
Industrial Arts	-	-	-	-	9	12	3	2
Fine Arts	12	10	10	6	6	8	2	2
Music	12	12	12	8	8	8	2	2
Physical Education	12	12	12	12	12	12	3	2
Scott	12	6	6	6	6	6	3	1
Physiology & Hygiene	8	4	4	4	4	-		
Health Education	-	-	-	-	-	4	1	2
Selective Voc. Courses	18	10	10	10	10	12-16		
Vocational Instruction	-	-	-	-	-	2	1	1
Guidance Activity	-	-	-	-	-	6	3	1
Total Periods Per Week	31	31	31	30	30	31-35		

1. The Table is derived from Public Junior High School Curriculum, 1968, Ministry of Education, Cheng-Chung Book Co., Taipei, Taiwan, pp.321-360.

2. * means optional.

Table 14 and 15 present the frequency of curriculum revision in the subjects offered and the time allocation for both junior and senior high schools from 1945 to the 1970's. Most of the objectives of the revised high school curricula within the past thirty years are presented as follows:

1) To strengthen nationalism education and moral education: Because of the ideology of the national reconstruction, Dr. Sun Yat-Sen's "Three Principles of the People" seems to be the doctrine to cultivate national spirit for the student body. For the purpose of intensifying moral education, the formal courses "Civics" and "Moral Education" are combined into one course with as much emphasis on the study as on the actual practice of moral principles.

2) To reinforce the learning of Chinese cultural traditions: In order to reinforce the learning of Chinese cultural traditions, more selections from the 'Confucius Classics' are taken in the courses of "Moral Education" and "Chinese Literature".

3) To introduce new courses of study: Industrial Arts, Political Science, History Culture, Earth Science are introduced in the curriculum.

4) To reallocate the number of teaching periods: The teaching periods are redistributed almost in every revision depending upon the result of implementation and upon the practicalities involved.

5) To reorganize subject matters and teaching methods: In junior high school curriculum, "Chemistry" and "Physics" were integrated to be a course entitled "Physics-Chemistry". This integrated course was taught in this manner from 1948 to 1967. In 1968, "Physics-Chemistry" was separated into two individual courses-- "Physics" and "Chemistry". The course of "Physiology and Hygiene" was replaced by "Health Education"; and "Handcrafts" was changed to "Industrial Arts".

6) To enforce vocational training and introduce electives: A greater range of selectives and vocational courses are prescribed and the courses are divided into two categories: Industrial Arts for skill training and Academic Subjects for advanced studying.

7) To reorganize the elective system: In senior high school curriculum, the Social Science Program and the Natural Science Program were introduced in 1945. These elective programs were combined into one program in 1948 (see Table 14). However, the concept of diversification for adapting to the individual differences of the students and the coodination of entrance examinations for higher education propted the reintroduction of the elective system in 1962. This system is still in operation today.

8) To improve the contents of subject matter: The syllabus of all subjects was modified to meet the practical condition and to avoid repetition. The content of courses was built in appropriate sequence in the cyclic arrangement

of the curriculum at both high school levels. Science education was improved by introducing modern teaching materials. The contents of the courses "Music", "Fine Arts", "Physical Education", and "Industrial Arts" were also improved to make learning more meaningful to life in Taiwan.

3-2-3 The Current Curriculum of Junior High Schools

The high school curricula in Taiwan indicate the number of weekly teaching hours for each subject in each grade. They offer detailed objectives, content and instruction to be followed by teachers in each teaching subject. The current junior high school curriculum is called the Nine-Year Free Education Program, which was promulgated in 1968. Their objectives, courses of study and changes will be discussed accordingly.

1) Nine-Year Free Education Program

Before the implementation of the Nine-Year Free Education Program in 1968, the Ministry of Education organized a National Curriculum Committee for the revision of curriculum standards in elementary and junior high schools in October , 1967. The Committee was composed of 172 curriculum specialists, educators, professors of pedagogical institutes, principals, and experienced teachers with eighteen Sub-Committees. A total of eighty-two meetings were held by the members of these Sub-Committees. Their work basically consisted of:

A. examing the previous programs of studies

B. comparing the curricula of developed countries

C. discussing such fundamental factors in curriculum building as general objectives of public education, specific objectives and contents for each subject, stages of psychological development and interests of teenagers, social activities and needs of individual student, and analysis of local community life.

D. designing a draft of nine-year curriculum

The new nine-year curriculum for both elementary and junior high school in a straight sequence was promulgated in January 1968 and put into effect in August of the same year. A three year period was allowed to complete implementation.[1]

2) The Objectives of Junior High School Curriculum

The curriculum for children of the ages 12-15 took into consideration the characteristics of the adolescent--his curiosity, idealism, desire for independence, his search for values, earlier sophistication and maturation, a concern with physical growth, the need for approval, and intellectual expansion. The curriculum offerings were developed in accord with the accepted functions of the junior high school, with

1. Nine-Year Universal Free Education in Taiwan, Taiwan Provincial Dept. of Educ., Taichung, Taiwan, May, 1969.

particular reference to providing common experiences for everyone and making available exploratory experiences of a wide range and variety. Such opportunities facilitate discovery and help to develop numerous special abilities and interests of adolescents.

The objectives of junior high school curriculum are listed as follows:[1]

A. To continue the fundamental education of the elementary school.

B. To practice and understand the ideas of physical and mental health.

C. To appreciate moral and ethical principles for development of good character and self-respect.

D. To enrich the cultural experiences to be a good citizen.

E. To develop scientific methods and attitudes.

F. To gain the basic knowledge and skills necessary for a more fulfilled life.

In view of the general nature of these objectives, it cannot be assumed that these objectives were only confined to the junior high school. They could also be applied to other levels of the school system. The unique objective was to provide for a transition from the total life of the pre-adolescent to the new life of the young adult and to cultivate a righteous and progressive citizen.

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1. Public Junior High School Curriculum, 1968, the Ministry of Educ., Cheng-Chung Book Co., Taipei, Taiwan, p.1.

3) The Courses of Study

The courses of study were in keeping with the objectives of the junior high school. These courses were most adaptable and provided guidance and exploratory experiences. They were transitory in nature, shifting the emphasis from basic learning to more specialized subject matter. This served the purpose of better preparing junior high school students for senior high school study.

The scheduling of course content provided more flexibility in the junior high school program. The administrative organization for instruction, however, was determined by the individual school in light of its own facilities and instructional staff, but within the norms of the supervision of the Taiwan Provincial Department of Education.

According to the new curriculum standards, the emphasis was placed upon "practical" education with the basic objective of providing all adolescents with a broad, general and common education. This basic knowledge and skill was intended to serve as a basis for discovering and exploring their individual interests, aptitudes and abilities.

Table 16 shows the weekly courses of study in elementary and junior high school of Taiwan.

Table 16. Subjects & Weekly Hours of Elementary and Junior high schools[1] (Weekly Min. for Ele.)

Subject \ School level / Grade	Elementary School 1 2	3 4	5 6	Junior High School 1	2	3
Civics & Ethics	120	120	120	2	2	2
Health Education	60	60	60	1	1	1
Mandarin	390	420	420			
Chinese				6	6	6
Mathematics	90	150	180 210	3-4	3-4	3-4
Abacus		120				
English				2-3	2-3	2-3
Social Studies		60	90			
General Knowledge	120					
History				2	2	1
Geography				2	2	1
Nature Study		90	120			
Natural Science				3	4	4
Singing and Playing	180					
Physical Education		120	120	2	2	2
Music		90	90	2	1	1
Fine Arts		60	60	2	1	1
Craft Work	120	90	90			
Industrial Arts or Home Eco.				2	2	2
Introduction to Professions					1	
Plantation, or Drawing, or Abacus					2	
Electives: Agriculture, Industry, Commerce, Home Economics, Science, English, Music, Arts. etc.						4-6
Boyscott				1	1	1
Group Activities	120	150	150			
Guidance Activities				1	1	1
Total	1200	1440	1500 1530	31-33	31-35	31-35

1. Education in The ROC., 1972, Ministry of Educ., Taiwan, p.31.

Many changes were made in the junior high school curriculum. The following major points gave a new direction to learning for junior high school students:[1]

A. To strengthen the life education, the subjects "Civics and Ethics", "Health Education", and "Guidance Activities" placed emphasis on behavioral guidelines and knowledge of daily living.

B. The weekly hours for "English" and "Mathematics" were changed to be flexible, but electives "English" and "Science" were added in the terminal year to meet the student's needs and the realistic local requirements.

C. The content of "Chinese" and social studies including "History" and "Geography" placed emphasis on national patriotic education for all students.

D. The contents of "Mathematics" and "Science" were planned to reduce the repetition. Emphasis was put on scientific attitudes and methods referring to updating scientific knowledge and the weekly hours were increased. The subject "Science" was re-separated into three branches: "General Nature Study", "Chemistry" and "Physics".

E. The vocational electives were very much emphasized in the junior high school program. With the exception of "Industrial Arts" for boys and "Home Economics" for girls as requirement courses, many electives were compatible with the interests of individual student and needs in community,

1. <u>Public Junior High School Curriculum</u>, 1968, the Ministry of Educ., Cheng-chung Book Co., Taipei, pp.357-359.

such as "Agriculture", "Industry", "Commerce" etc., which gave students job skills for later employment.

F. The selective learning system was partially implemented. Second school year students might select two to three electives for 4 to 6 weekly hours, either in vocational or academic courses.

G. Each class had one hour per week for weekly assembly, class meeting, and extracurricular activities which were not listed in the table.

H. The total weekly hours were flexible from 31 to 35, dependent on the needs of local school and students.

3-2-4 Senior High School Curriculum -- 1971 Provision

Since the 1964 curriculum revision of senior high school had been carried out seven years, and since the graduates from junior high schools after the implementation of the Nine-Year Free Education Program in 1968 was upgraded, the Ministry of Education planned a new curriculum revision to connect the junior high school curriculum within the overall educational sequence. This revision originated in July 1970, followed by the establishment of the committee for the revision of the senior high school curriculum with eighteen sub-committees, one for each subject. The committee adopted the draft of the new curriculum in February 1971.

After the final draft was promulgated in 1971, a three year period was allowed to complete its implementation. The major points of emphasis in the revised curriculum were analyzed as follows:

1) The Objectives of Senior High School Curriculum

The educational objectives of the senior high school curriculum were based on those of the junior high school curriculum, as well as specified objectives being offered:[1]

A. To help students appreciate culture and beauty in their world.

B. To provide scientific education and military training.

C. To prepare students who are planning to continue their advanced studies of professional education.

D. To foster in them citizenship and morality.

E. To cultivate the talented youth for the improvement of society and country.

In other words, the aims of the senior high school education was to continue educating the student who had completed the nine-year basic education. It served general cultural cultivation, scientific education, and military training to ensure the knowledge and skills acquired at

1. Senior High School Curriculum, the Ministry of Educ., Cheng-chung Book Co., Taipei, 1971, p.400.

advanced level. This senior high school education will lead to further educational opportunities and to the extent of student's physical and mental capacity.

2) The Courses of Study

At the age of fifteen, students entering the academic field were expected to undertake the core curriculum in their first year. They undertook the same subjects, periods per week and content. From the beginning of the second school year there were two options for the last two years of study. There were the "Natural Science Program" and "Social Science program". Table 17 shows the weekly courses of study in senior high school of Taiwan.

There were some changes in this revision as compared with the revision implemented in 1964:

A. There was not much difference concerning the objectives. The only difference was the continuation of education of the student who had completed the nine year basic educational program.

B. There were more subjects offered in the new revision, such as seventeen required courses and many electives. "Earth Science" was introduced to the Natural Science Program. A great emphasis was also placed upon basic subjects such as "Chinese Literature", "Mathematics", "Social Studies", and "Natural Sciences" in order to improve the intellectual quality

Table 17. SUBJECTS AND WEEKLY HOURS OF SENIOR HIGH SCHOOL[1]

SUBJECT / Year / Semester	Social Science Program						Natural Science Pragram					
Year	1st		2nd		3rd		1st		2nd		3rd	
Semester	I	II	I	II	I	II	I	II	I	II	I	II
Civics	2	2	2	2	-	-	2	2	2	2	-	-
Three Principles of the People	-	-	-	-	2	2	-	-	-	-	2	2
Chinese Literature	6	6	7	7	7	7	6	6	5	5	5	5
English	6	6	7	7	7	7	6	6	5	5	5	5
History	2	2	2	2	-	-	2	2	2	2	-	-
History of Culture	-	-	-	-	2	2	-	-	-	-	-	-
Geography	2	2	2	2	-	-	2	2	2	2	-	-
Political Geography	-	-	-	-	2	2	-	-	-	-	-	-
Earth Science	-	-	-	-	-	-	-	-	-	-	2	2
Mathematics	4	4	4	4	4	4	4	4	6	6	6	6
Physics	-	-	-	-	3	3	-	-	-	-	6	6
Chemistry	-	-	3	3	-	-	-	-	6	6	-	-
Biology	3	3	-	-	-	-	3	3	-	-	-	-
Physical Education	2	2	2	2	2	2	2	2	2	2	2	2
Military Education (or Nursing)	2	2	2	2	2	2	2	2	2	2	2	2
Music	1	1	1	1	-	-	1	1	1	1	-	-
Fine Arts	1	1	1	1	-	-	1	1	1	1	-	-
Industrial Arts (or Home Economics)	2	2	2	2	-	-	2	2	2	2	-	-
Optional Courses	-	-	-	-	2-5	2-5	-	-	-	-	2-5	2-5
Total	33	33	35	35	33-36		33	33	36	36	32-36	

a) One hour per week for weekly assemly, class meeting, and co-curricular activities are excluded from this table.

b) Optional courses are provided in accordance with actual needs and on a flexible basis.

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1. Education In The Republic of China, 1972, Ministry of Education, Taipei, Taiwan, p.32.

of the regular school program. A great range of electives and job training courses were prescribed and were placed into two categories -- skill knowledge and academic knowledge. These courses were only given in the terminal year with the purpose of providing alternative courses for pupils with varying interests and abilities.

C. In the second and third school years, the social science majors had two additional hours per week of "Chinese Literature" and "English". The content of these courses was compiled in accordance with actual needs and teaching periods. For natural science majors, there was a total of five additional hours for "Mathematics", "Chemistry", and "Physics" in the second and third years. The content of mathematics and sciences was different from that of the social science program. The emphasis of the curriculum was clearly placed on education for the academically elite with a basic objective of differentiation of knowledge in order to prepare students for advanced studies.

D. The allotment of instructional time was readjusted.

The Year of Revision	Weekly Hours				
	1st year	2nd year		3rd year	
		SSP	NSP	SSP	NSP
1964	32 - 33	33-35	34-36	31-36	31-36
1971	33	35	36	33-36	32-36

SSP: Social Science Program. NSP: Natural Science Program.

The amount of time devoted to the elective courses was reduced, and time freed by this alteration was allotted to the subject area of literature and language in the Social Science Program and the subject area of sciences in the Natural Science Program.

E. Content of subjects was changed in nearly every subject. The emphasis in the curriculum paid a great deal of attention to the traditional cultural teaching materials for the social studies. The content of science subjects was based on the original subject material; reorganization added up-to-date materials from the Biological Sciences Curriculum Study (BSSC), the Chemical Education Material Study (CHEMS), the Chemical Bond Approach (CBA), and the Physical Science Study Committee (PSSC).[1]

3 - 3 Summary

Secondary education and the high school curriculum in Taiwan during the years 1945-75 may be summarized as follows:

1) Secondary education in Taiwan, as elsewhere in the world, underwent changes of great significance, involving reform of the school system in both quantitative and qualitative aspects.

2) The significant changes of the secondary educational

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1. Senior High School Curriculum, the Ministry of Educ., Cheng-chung Book Co., Taipei, Taiwan, 1971, pp.408-9.

system were:

A. Instead of being dominated by a privileged few, the opportunities of secondary education were made available to every citizen according to his needs, capacities and willingness to devote the necessary effort.

B. There was a trend to develop differentiated studies as well as limited academic education to meet various social and economic needs.

C. There was a growing emphasis on the need for special qualifications and for a good general education to secure entry into an increasing number of occupations.

D. The rapidity of industrial and technological changes presented an exciting challenge for those who could qualify themselves as scientists, technologists, and technicians. The number of these students produced by high schools rose rapidly and continued to do so.

3) The major changes of the high school curriculum may be characterized as follows:

A. The structure of the curriculum was formulated by the Ministry of Education of Taiwan. Generally, this structure was developed according to the following principles:

a. To provide a program which considers the great variety both in type and degree of talents, aptitudes and interests represented in the entire population.

b. To give every individual physical and mental health, intellectual ability, economic effeciency, moral responsibility, aesthetic appreciation and a spiritual foundation that will give direction and meaning to life.

B. The curriculum for Junior high school and elementary school were reorganized in a nine-year sequence, thus eliminating overlapping and duplication. It emphasized character building, citizenship training and practical knowledge so as to facilitate further schooling and employment.

C. The curriculum for senior high school was divided into two sections at the end of the first year: the Natural Science Program and the Social Science Program. The former aimed at developing pupil's abilities to observe and to experiment, and at developing the spirit of a search for truth, while the latter's emphasis was upon ethical and democratic education, and instilling the correct social concepts. The high school curriculum also emphasized vocational and technical training in addition to basic subjects in the preparation of the student for employment after graduation.

D. The weekly schedule for a student contained twelve or more subjects. Most subjects were compulsory for the student throughout all his years of study. A few subjects and electives were taught only to the limited extent of one or two years. The combined weekly hours averaged between thirty-one and thirty-six.

E. Following the humanistic tradition, the subjects dealing with literature, language and written thoughts (Civic and Moral, Dr. Sun Yat-Sen and Confucius Teachings) were believed to have greater educational value for humanism. Mathematics and Sciences were also held in great esteem as training in logical thought and in scientific attitudes. Traditionally, Music and Fine Arts were ranked as "Minor" subjects, but in recent years the system has given greater importance to these two subjects. This emphasis may be attributed to an increased amount of time for leisure and the concomitant trend toward participation in leisure activities.

F. Recently, the curricula also offers a variety of vocational subjects. This trend is due to the great advances in technology which have made obvious the need for all young people to obtain more vocational training and specialization to meet the requirements of industrial progression.

G. The Ministry of Education also prescribes the objectives, contents and instructions of each subject as well as curriculum guidelines to be followed by the teachers of these subjects. The official guidelines of the later revisions contain more numerous and detailed recommendations on the modern way of teaching than did earlier revisions. The most fundamental feature of curriculum revision was the correlation to be sought:

a. among the different subjects themselves,

b. between the subjects taught and the aptitude, interest, and abilities of pupils,

c. between the instruction imparted and real life in its social and mental environment.

Finally, as has been illustrated, the emphasis of the secondary education and high school curriculum in Taiwan has shifted from the theoretical knowledge to more practical aspects and actual life situations.

CHAPTER 4

SECONDARY SCHOOL SCIENCE EDUCATION

This chapter provides an overall study of secondary school science education in Taiwan during the three decades, 1945 - 1975.

During the years immediately following World War II, Taiwan was confronted with a critical shortage of trained science teachers as well as a severe lack of laboratory facilities at all school levels. A great deal of effort was devoted to increasing the quantity and quality of science teachers and facilities at this stage.

During the 1950's, more emphasis was placed on those aspects to improve contents, methods, and experiments in science education.

At the beginning of the 1960's, the reform movement in secondary science education was initiated. New science curricula for junior and senior high schools were developed. Since then, high school science curricula and teaching materials have been modernized in both subject content and method of instruction.

In this chapter, a more detailed description of the development of science education in Taiwan secondary schools shall be offered. An evaluation of its current state with recommendations will be included.

4 - 1 Development of Science Education

In Taiwan, the development of science education has been one of the government's main aims. During the post World War II years, the Japanese colonial educational system was replaced by Chinese democratic and traditional educational system. Taiwan was confronted with a great deal of educational adjustment and a rapidly expanding school system. That there were critical shortages of facilities, inadequatly prepared teachers and overcrowded classes in all public schools was apparent. During this period 1945 - 1950, a great deal of effort was devoted to increasing the quantity and quality of science teachers and laboratory equipment at all school levels.

During the 1950's, more emphasis was given to those aspects designated to improve content, method, and experiments in science education. The primary motivation for such an effort was to increase both scientific man-power and facilities. With the growth of science education, a steady improvement in teaching staffs and equipment began in all types of schools. In urban areas, secondary schools possessed a considerable body of older teachers who were well qualified and competent. Most of these teachers were immigrants from mainland China. Later, the young graduates, fresh from Taiwan Normal University and teachers' colleges were able to fill the key positions in

Taiwan secondary schools. In building laboratory equipment, substandard high schools having greater initial deficiencies concentrated upon including apparatus for demonstration purposes.

4-1-1 The National Science Council (NSC)[1]

The National Science Council is a cabinet level agency in charge of science development policies and allocation of funds. Between the late 1950's and early 1960's, due to the extraordinary technological developments in Taiwan, a great national interest in having a scientifically literate society emerged. This created educational provisions insuring a sound general education in science for future citizens. It also initiated the specialized training of potential scientists, technologists, and technicians. A long-range science development program was launched in 1959 and was conducted by the NSC. It has since provided science development policies and funds for research as well as developmental work on the teaching of science.

The NSC has six divisions:

1) Natural and Mathematics Sciences,

2) Engineering and Applied Science,

3) Biological, Agricultural and Medical Sciences,

1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.95.

4) Humanities and Social Sciences,

5) Science Education, and

6) International Programs.

The major work of the NSC is to conduct a long-range science development program which includes:[1]

1) Recruitment of Chinese scientists from abroad,

2) Encouragement of research among university professors and science workers,

3) Provision of study grants to science people for advanced studies,

4) Emphasis upon basic science research, such as diverting efforts and funds to engineering and applied science and supporting science projects,

5) Establishment of scientific cooperation with other countries,

6) Collection and dissemination of the latest scientific and technological information, and

7) Assumption of responsibility for the designing and manufacturing of precision instruments and laboratory ware for research and industrial use.

In 1964, the long-range science development program was given new impetus following the Sino-American Conference on Science Cooperation held in Taipei.[2] At this conference, Chinese and American scientists established a permanent

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1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan pp.253-254.

2. Ibid., p.95.

committee in Taiwan which is sponsored by the Academic Sinica and one committee in the United States which is sponsored by the National Academy of Sciences. Sino-American science cooperation was upgraded to the government level with the signing of a cooperation agreement in 1969. This involves joint research projects, seminars, assistance in improving Chinese research institutions and an exchange of scholars.[1]

Recruitment of Chinese scientists abroad is one of the major tasks of the NSC in its efforts to upgrade science research and science education. The Science and Technology Information Center is in charge of the collection and dissemination of information concerning the latest scientific and technological development.[2]

4-1-2 The Reform of Secondary Science Education

Secondary science education in Taiwan was greatly influenced by the innovations in science teaching that occurred in the United States. When the Russians launched the first space satellite "Sputnik" in 1957, the reform movement was sparked to produce the most innovative and spectacular change in American science education ever developed in secondary schools.[3] Many modern curriculum programs such as the Physical

1. The China Year Book, 1975, China Publishing Book Co., Taipei p. 253.
2. Ibid., p. 254.
3. Alfred T. Collette, Science Teaching In the Secondary Schools Allyn & Bacon, Inc. Boston, 1968, p. 32.

Science Study Committee (PSSC), the Biological Sciences Curriculum Study (BSSC), the Chemical Education Material Study (CHEM), the Chemical Bond Approach (CBA), and the Introductory Physical Science (IPS) had been published and used experimentally.[1] This successful innovation sparked the reform of secondary science education in Taiwan by the late 1950's. The Ministry of Education approached the science program first with an evaluation of the current status of science teaching, curriculum, and equipment in all secondary schools. In 1958 and 1959, several educational conferences for high school science teachers were held to inspire teacher's interest and to discover their needs.

At the beginning of the 1960's the attention of scientists, administrators, educators, and teachers was focused on the problems of improving secondary science teaching. The "Plan for Developing Science Education in the Secondary Schools" was promulgated by the Science Education Council of the Ministry with the assistance of U.S. Aid.[2] The plan was operated on an ambitious revision of the current science curriculum and texts; the improvement in the quality of science teachers; and the modernization of science facilities. The major improvements may be summarized in the following areas:

1) The undertaking of curriculum and textbook revision in secondary schools to meet current needs in

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1. Alfred T. Collette, Science Teaching in the Sec. Schools, Allyn & Bacon, Inc., Boston, 1968, pp.99-127.

2. U.S. Technical Cooperation Education Project, Ministry of Education, 1963, Taipei, Taiwan, pp.47-48.

science education,

2) The provision of adequate science equipment for secondary schools and for teacher training institutions,

3) The provision of in-service training for science teachers at all levels to assure familiarity with and command of scientific advances and new teaching techniques.[1]

In November of 1962, the Ministry of Education in conjuntion with the National Science Council set up a Mathematics and Science Curricular Study Committee and since then has sent many educators and teachers abroad for advanced and updating studies.[2] There were four sub-committees under the curricular study committee. These four were Mathematics, Physics, Chemistry, and Biology. Many specialists were responsible for studying the newest curriculum materials, teachers' guides and laboratory manuals published in the United States. Each of these manuals was carefully discussed with respect to the needs of the local society. In 1964, the newly revised national curricula of mathematics and sciences for senior high schools were developed by the committees and issued by the Ministry of Education. The major contents of these new curricula may be summarized as follows:

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1. U.S. Technical Cooperation Education Project, Ministry of Education, Taipei, Taiwan, 1963.
2. Senior High School Curriculum Standard, 1970, Ministry of Education, Cheng-chung Book Co., Taipei, Taiwan, p.372.

1) The new courses of study were quite different from the traditional science courses. They not only provided students with the newest curriculum materials but also attempted to lead them through a series of investigations. These investigations encouraged the creative processes and brought students to discover and solve problems to a point where they could conceptualize the scientific knowledge they obtained. In this manner, emphasis shifted from knowledge to the application of this knowledge. Hence, more efforts were placed on scientific thinking, scientific attitudes, problem solving and appreciation.

2) The topics covered in these courses emphasized broadth and depth of scientific knowledge which would help students obtain a better understanding of sciences and preparation for advanced study.

3) Many new textbooks, laboratory manuals, and teachers' guides according to the new science curricula were compiled and published. As a general rule, these materials contained an improved, selected, and organized body of subject matter to help teachers fulfill the objectives of the curriculum.

4) Many new audio-visual teaching aids were prepared to be utilised with the texts. These audio-visual aids were extremely valuable in improving science teaching.[1]

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1. Senior High Shool Curriculum Standards,1970, Ministry of Education., Cheng-chung Book Co., Taipei, Taiwan, pp.372-374.

4-1-3 The Continuation of The Science Reform Movement

The science reform movement continued and by 1968 the Ministry of Education and the National Science Council were deeply involved in planning large curriculum revision projects for all courses at junior and senior high school levels. Since 1968, new science curriculum standards were developed and tested in both lower and upper secondary schools. They are now firmly established in both subject content, method of instruction and standards of laboratory facilities.[1]

Consequently, teaching materials, texts and teachers' guides were edited and printed by the National Institute for Compilation and Translation.[2] Moreover, teaching aids such as charts, tables, models, film slides and movies were supplied by the National Institute of Educational Materials to increase the effectiveness of teaching.[3]

In any future revisions, the following factors should always be considered:

1) Content of science subjects should be adjusted to meet students' learning abilities and interests, as well as the needs of the individual and the society.

2) Content should be revised to meet the weekly hours.

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1. Senior High School Curriculum Standards, 1970, Ministry of Education, Cheng-chung Book Co., Taipei, Taiwan, p.374.
2. China Year Book, 1975, China Publishing Co., Taipei, p.252.
3. Ibid., pp.252-253.

3) Content should relate to the problems in daily life and should be dealt with in great depth.

4) Laboratory work should be recommended at the beginning of each lesson to emphasize "learning by doing".

4 - 2 National Pattern of Secondary Science Education

In Taiwan, a curriculum standard which generally means the plan for instruction in a given grade was developed by the curriculum committee and issued by the Ministry of Education. The current status of science programs in secondary schools will be discussed.

4-2-1 Science Program for Junior High School

A. The General Trend in Science Courses

The general trend in science courses throughout Taiwan junior high schools has been toward generalized courses. Specific social and educational factors may be related as follows:

1) The nine-year free education program made the junior high school a second school for the education of the masses.

2) The ever-increasing advances in science brought about more and more demands on the future citizen for an

understanding of and adjustment to an environment with respect to scientific discoveries and inventions.

3) The functional understanding of facts, principles and concepts, the growth in the use of scientific methods, and the acquisition of scientific attitudes, appreciation, interests and skills were seen as the means to the end of a more effective adjustment to new situations.

4) The present natural science curriculum of public junior high schools issued by the Ministry of Education in 1968 dealt with Biology, Chemistry and Physics respectively.[1] The general aims for natural sciences were to give the pupils an understanding of common natural phenomena through observation and investigation, to cultivate the interest and spirit of rational creativity, to recognize the contribution of science to human prosperity, and to apply scientific knowledge and ability in daily life. The following table is a brief outline condensed from foregoing sources.

Table 18. Curriculum for Junior High School Sciences[2]

Natural Science: Biology
Time Allocation: 3 hours per week including experiments. 1st school year, Lecture: 70 hours / sch.yr. Experiment: 34 hours / sch.yr.

Continued

1. Public Junior High School Curriculum Standard, 1968, Ministry of Education, Cheng-chung Book Co., Taipei, pp.99-120.

2. Ibid., pp.99-120.

Contents:	1. Science spirit and method 2. Living organisms & non-living things 3. Basic structure & functions of living organisms 4. Plant life 5. Plant classification 6. Animal life 7. Animal classification 8. Living organisms & their environment 9. Heredity of living organisms 10. Prehistory life
Natural Science:	Chemistry
Time Allocation: 2nd & 3rd sch.yr.	2 hours per week including experiments Lecture: 35hrs/sch.yr. 70hrs in total Exp't: 35hrs/sch.yr. 70hrs in total
Contents:	1. Separation of matter 2. The effect of heat on matter 3. Air 4. Combustion 5. Elements 6. Water 7. Preparation of chemicals from rocks 8. Preparation of chemicals from ocean 9. Atoms ---------- 10. Investigation of hydrogen chloride 11. The periodic table 12. Atomic structure of elements 13. Solids, liquids, and gases Continued

Contents:	14. Acids, bases and salts 15. Electrolytes 16. Relative number of particles in Chemical reaction 17. Catalyst and rate of reaction 18. Chemical resources in earth crust	
Natural Science:	Physics	
Time Allocation: 2nd & 3rd sch.yr.	2 hours per week including experiments Lecture: 35hrs/sch.yr. 70hrs in total Exp't: 35hrs/sch.yr. 70hrs in total	
Contents:	1. Matter and molecules 2. Massing & building micro-balance 3. Length, volume, density, and time 4. Force 5. Law of levers 6. Investigation of spring forces 7. Liquid pressure, buoyancy and Archimede's Principle 8. Atmospheric pressure, barometer and molecular movement of gases 9. Measurement of molecules 10. Heat ---------- 11. Vibrational motion and waves 12. Light 13. Simple motion 14. Newton's laws 15. Work and energy 16. Circuits and electricity 17. Electric potential, resistance, power and energy	

Continued

Content:	18. Static electricity 19. Magnets and magnetism 20. Electronic theory 21. Introductory to the development of physics

B. The general Features of Science Curriculum

The general features of science curriculum in junior high school will be discussed:

1) The authorized curriculum was less flexible in Taiwan than in North America. The treatment of the subject was formal and followed a prescribed syllabus. The time allocation to science curricula was substantial and remarkably uniform. The following table shows opinions on the compulsory or optional science courses in junior high schools, given by teachers and students selected to participate in this study.

Table 19. The Compulsory or Optional Junior Science Courses[1]

Categories	Opinion	Percentage of person		
		Biology	Chemistry	Physics
Teachers	Compulsory	78.0	68.0	59.9
	Optional	3.1	6.0	-
	Others	18.9	26.0	40.1
Students	Compulsory	59.1	60.4	53.8
	Optional	14.7	10.8	23.3
	Others	26.2	28.8	22.9

1. National Science Council, Public Junior High School Science Education Survey, Taiwan, 1974, p.182.

2) Most countries favored an integrated science course at the junior high school level, but in Taiwan the various disciplines of science (Biology, Chemistry and Physics) were organized in a sequential rather than a concurrent manner. There were two possible reasons: one reason was the availability of suitable qualified teachers for each branch; another reason was the paucity of teachers who had any background training in two or more sciences and therefore unable to give integrated programs. According to an associated survey, the majority of teachers of junior high school science believed that the materials could be integrated and related to the pupil's environment. The following table shows these opinions on the integration of current science courses of Biology, Chemistry and Physics.

Table 20. The Integration of Current Biology, Chemistry and Physics be into One "General Science"[1]

Opinion	% of Public Junior High School Teachers		
	Biology	Chemistry	Physics
Yes	55.4	53.2	49.5
No	43.8	44.0	46.6
Others	1.8	2.8	3.9

1. National Science Council, Public Junior High School Science Education Survey, Taiwan, 1974, p.183.

The majority of science teachers agreed upon the integration of the sciences as they taught more than one area of science in the school. Also, if a modern general science course was to be developed to meet the new trend in science education, it should draw upon all the sciences for its content. The organization of such a curriculum should relate to the broad areas of human activity in which the selected content and methods of science played important roles.

3) An emphasis placed on the science curriculum and textbooks would appear to be important. There was uniformity in the total content of texts for all compulsory education. The National Institute for Compilation and Translation took the responsibility for editing and publishing. The quantity and quality of teaching materials in science texts were evaluated and the results are shown in Table 21.

Table 21. The Quantity of Teaching Materials in Science Textbooks [1]

Quantity of Teaching Materials	% of Junior High School Sc. Teachers		
	Biology	Chemistry	Physics
Too much	47.6	17.0	77.6
Adequate	38.6	55.0	9.8
Not enough	8.7	16.5	10.6
No opinions	5.1	12.0	2.0

1. National Science Council, Public Junior High School Science Education Survey, 1974, Taiwan, p.183.

Table 21 indicates that the quantity of teaching materials was excessive in Biology and Physics texts. The Chemistry texts had adequate quantity of teaching materials. The selection of science content was recommended by teachers[1] as shown in Table 22.

Table 22. The Selection of Science Content As Recommended by Junior High School Science Teachers

Subject	Content Emphasis	% of Teachers
Biology	1. Overall introduction to Biology	49.2
	2. Topics of life science in detail	47.1
	3. No opinion	
Chemistry	1. Basic chemistry knowledge	36.0
	2. Needs of individual and society	20.0
	3. Problems related to student's learning ability and interest	43.0
	4. No opinion	1.0
Physics	1. Sequential introduction of physics	37.0
	2. Content related to living situations and activities	10.0
	3. Problems closely related to human life and student's learning ability	52.0
	4. No opinion	1.0

C. The Methods of Instruction

The methods of instruction in Taiwan junior high school science teaching tended to emphasize lectures, text

1. National Science Council, Public Junior High School Science Education Survey, 1974, Taiwan, p.184.

recitations, quiz sections, work book exercises, and discussion and demonstrations. Other instructions such as individual projects, group investigation, field trips, practical experience in gardens and a profusion of teaching aids were dependent on the individual teacher. The first hand laboratory experiences were provided at a minimum in junior high schools. This was due to the classes being too large for successful laboratory work as well as lack of equipment, time and money for individual laboratory work. Table 23 shows the average groupings for laboratory work in junior high schools.

Table 23. Average Groupings in Junior High School Science Laboratory Work[1]

Number of Students in Group	% of Public Junior High School		
	Bio. lab.	Chem. lab.	Phy. lab.
1	1.0	1.2	0
2 - 3	6.8	2.5	2.8
4 - 5	33.7	12.6	12.8
6 - 8	48.3	65.1	67.7
9 - over	10.2	18.6	16.7

Most schools had an average grouping of 6-8 students in science laboratory work. Therefore, science teachers usually taught science by lecturing or using demonstration method. Students were therefore unable to participate in

1. National Science Council, Public Junior High School Science Education Survey, 1974, Taiwan, p.186.

practical activities which could satisfy their mental curiosity concerning phenomena and the practical applications in the field of science.

The proper use of sensory aids by science teachers should enrich and vitalize their instruction and help the pupils learn initial concepts accurately. Thus, in 1956, the National Institute of Educational Materials was founded[1] and was responsible for the acquisition, compilation and exhibition of educational materials. It also operated an educational radio broadcasting and television station. As of December 1974, the institute had collected 39,395 items of Chinese and foreign educational materials including magazings, textbooks, catelogues, and audio-visual science curriculum aids which can be freely borrowed by schools. Table 24 shows the percentage of science teachers using visual aids in the teaching of science.

Table 24. Percentage of Junior H.S. Science Teachers Using Visual Aids in Teaching Science[2]

Visual Aids	% of Teachers Using Visual Aids		
	Biology	Chemistry	Physics
Charts	35.7	8.3	24.0
Specimens and models	51.5	11.3	43.4
Electrical teaching aids	11.5	3.8	17.1
Demonstration and Exp'ts	-	45.3	-
Individual projects	-	-	15.5
Blackboards	-	31.3	-
Others	1.3	-	-

1. China Year Book, 1975, China Publishing Co., Taipei, p.253.
2. National Science Council, Public Junior High School Science Educ. Survey, 1974, Taiwan, p.185.

Prior to 1968, the National Institute for Compilation and Translation organized a Committee for Compilation and Examination of Textbooks. The Committee has compiled and published 264 volumes of university texts, 132 volumes of junior college texts, 65 volumes of senior high school texts, 160 volumes of junior high school texts, and 189 volumes of elementary school texts and teachers' guides.[1] It also examined and approved 12,517 secondary and elementary school textbooks published by various textbook companies. Most of these textbooks were accompanied by teachers' guides. The following Table 25 shows the percentage of science teachers using teachers' guides in science teaching.

Table 25. Percentage of Junior High School Science Teachers Using Teachers' Guides[2]

Frequencies of Usage of Teachers' Guides	% of Science Teachers		
	Biology	Chemistry	Physics
Often use it	28.2	25.0	19.4
Occasionally use it	30.4	25.0	19.0
Never use it	24.7	50.0	42.6
Unware of existence	16.7		19.0

The teachers' guides were criticized by public junior high school science teachers.[3] There were 32.20% teachers who pointed out that teachers' guides were a great help in science

1. *China Year Book*, 1975, China Publishing Co., Taipei, p.252.
2. National Science Council, *Public Junior High School Science Education Survey*, 1974, Taiwan, p.186.
3. Ibid.,p.186.

teaching; 50.5% thought that they were helpful but not too much; and 17.1% teachers criticized that they were not helpful at all.

D. Teaching Staff

In regards to public junior high school science teachers, specifically, there was the need for competent instructional personnel to provide for the education and the training of future scientific and technological human resources. In view of this consideration, the source of junior high school teachers, their teaching subjects and their service training were surveyed by the National Science Council in 1974.

Table 26. Sources of Junior High School Science Teachers[1]

Pre-service Education	% of Teachers in Teaching		
	Biology	Chemistry	Physics
Normal university & teacher's college, science major	18.3	8.0	4.3
University & college, science major	4.5	7.5	5.4
University & college, science related field	33.2	57.0	41.7
University & college, science non-related field	11.6	8.5	31.5
Equivalence & others	32.4	19.0	17.1

From the study, one disproved misconception about science teachers was that they were graduates of normal university or teacher's college, whereas in actuality the

1. National Science Council, Public Junior High Science Education Survey, 1974, Taiwan, p.179.

vast majority of the science teachers were university and college graduates who happened to have majors or minors in one or more of the sciences. Another misconception was that science teaching in the junior high school was less important than that in the senior high school. Thus the less prepared and the inexperienced teachers were often assigned to the junior high schools. This was considered somewhat unfortunate, as the science instruction during these important stages made a great difference in student's attitudes toward further more advanced studies in the sciences in later years.

There were many junior high schools in which one science teacher had to teach more than one of the science courses offered. Table 27 shows the teaching subjects undertaken by science teachers in public junior high schools.

Table 27. Percentage of Science Teachers in Teaching Subjects of Public Junior High School[1]

Teaching Subjects	% of Teachers in Teaching		
	Biology	Chemistry	Physics
Major field only	15.0	15.0	13.6
Major field and Chemistry	24.5	-	50.0
Major field and Physics	14.0	52.0	-
Major field and Biology	-	16.5	6.4
Major field and Mathematics	5.4	5.0	10.8
Major field and Health Educ.	27.1	4.0	-
Major field and others	18.5	7.5	19.2

1. National Science Council, Public Junior High School Science Education Survey, 1974, Taiwan, p.179.

It was consider that a prospective science teacher must be competent in his own field and must also have adequate background to teach other sciences and to handle them effectively at the junior high school level.

With respect to ill-prepared science teachers, it was recommended that constructive in-service assistance should be provided. Evaluation of both pre-service and in-service education of public junior high school science teachers is shown in Table 28.

Table 28. The Evaluation of Pre-service and In-service Education for Junior High School Science Teachers by Educational Administrators

Service Education	Effectiveness	% of Educational Administrators
Normal university & Teachers college pre-service and in-service training	Very helpful	65.3
	Helpful	32.2
	No help	2.4
Modern inquiry instruction workshop	Very helpful	39.9
	Helpful	53.0
	No help	7.1
Evaluation of learning outcomes workshop	Very helpful	36.1
	Helpful	48.5
	No help	15.4
Science Education Experiment Center laboratory workshop	Very helpful	44.2
	Helpful	50.2
	No help	5.6

1. National Science Council, Public Junior High School Science Education Survey, 1974, Taiwan, p.181.

Beginning 1958, the In-service Training Center was set up in National Taiwan Normal University to train secondary school teachers by rotation for a period of two weeks to 17 weeks.[1] Since then, in-service training programs for science teachers have developed rapidly in Taiwan. As indicated in the foregoing table, most school administrators evaluated the in-service training as very helpful, and encouraged teachers to participate in workshop experiences. According to the survey, the following recommendations for science teacher's education are suggested:

1) In-service training should be continued, so far as its achievements merit.
2) Format and methods of in-service training should be flexible enough to meet the needs of individual teachers.
3) In-service training should emphasize the modernization and reinforcement of not only teacher's expertise in their individual field, but also of teaching materials, techniques and evaluations.
4) In-service training should be sequentially organized in the order of priority, as teaching techniques and evaluations, teaching materials and individual specializations.
5) The enrollments of students into teacher's education

1. Education in the Republic of China, The Ministry of Education, 1972, Taipei, Taiwan, p.26.

programs should be selective and correlated with the current demands for teachers within the school system.

6) A system should be introduced whereby the individual teacher's ability to work outside his area of specialization would be increased.

7) Within the junior high school system, a greater emphasis should be placed upon enabling teachers to work within their specialization.

According to the latest information, the Ministry of Education intends to improve current junior high school science education. A team of 17 educators has been established consisting of superior science teachers, curriculum specialists and administrators who went abroad to observe and to investigate the general science curriculum planning and implementation in the United States, Japan and other countries. These educators will assist in further planning and adaptation at the local level of junior high school science education in Taiwan.[1]

4-2-2 Science Program for Senior High School

A. The Sciences Studied in Senior High School

According to the guideline laid down by the Ministry of Education concerning senior high school education "The aim

1. The Central Daily News, March 15, 1978, Taipei, Taiwan.

of general senior high school is to prepare students for college education.[1] Science education in senior high schools was first influenced by college entrance requirements and was college-preparatory in nature. The sequence of science courses at this level has traditionally been Biology in the first year, Chemistry in the second year and Physics in the third year. At the beginning of this decade (1971, see Chapter 3, Table 14) a fourth science subject Earth Science came into this sequence and has since gained considerable recognition.

In accordance with the Senior High School Curriculum Standard,[2] each of these sciences may well contribute to the major objectives of science teaching. In general, they may well have certain things in common, such as understanding of facts, concepts and principles, acquisition of instrumental techniques and problem-solving skills, development of growth in creative thinking, scientific attitudes and appreciations. Since science is a great social force as well as a method of investigation, both teachers and students have a great opportunity and responsibility to make a large contribution to the welfare and advancement of humanity.

B. The Science Development in Senior High School

After World War II, the science program development started undergoing a quiet revolution which involved changing

1. Sinorama, Vol. 3, No. 2, Feb. 1978, China Publishing Co., Taipei, Taiwan, p.3.

2. Senior High School Curriculum Standard, Ministry of Educ., Cheng-chung Book Co., 1971.

the time given to the study of science, the relative emphasis given in the curriculum to the different branches of science, the quantity and quality of instruction and the importance in the curriculum of different items of content included in the college entrance examinations. During the past three decades, 1945-1975, the senior high school science program has been revised six times as shown in Table 29.

Table 29. Science Subjects and Weekly Hours in Senior High School Science Programs[1]

School Year		1945		1948	1955	1962		1964		1971	
		SSP*	NSP*			SSP	NSP	SSP	NSP	SSP	NSP
I	Biology	6	3	3	3	3	3	4	4	3	3
II	Chemistry	4	5	5	4	3	6	3	5	3	6
III	Physics	4	5	5	5	3	6	3	6	3	6
I	Minero-logy	-	2	-	-	-	-	-	-	-	-
III	Earth Science		-	-	-	-	-	-	-	-	2

* SSP = Social Science Program
NSP = Natural Science Program

Modern science curriculum programs such as PSSC, CHEMS, BSCS, CBA for the teaching of science have been developed and published in the United States. These innovations also initiated a reform movement in Taiwan. The serious re-thinking of the natural science curriculum dated back to the early 1960s when

1. Senior High School Curriculum Standard, The Ministry of Educ., Cheng-chung Book Co., Taipei, 1971, pp.361-409.

dissatisfaction with what was being taught in the schools ran high. Although the original texts and laboratory manuals of PSSC, CHEMS, CBA and BSCS had been translated into Chinese, local needs were better met by science teachers' personal adaptations of these materials. In November 1962 the Ministry of Education established a "Senior High School Science Education Development Committee" with four Sub-committees in Mathematics, Physics, Chemistry and Biology. They cooperated with the Association of Asia Foundation with the intention of improving the senior high school science programs and pedagogy.[1] A group of scientists, teachers, educators and administrators collaborated in the preparation of curricula, laboratory manuals, methodology guides, experiment equipment and audio-visual didactic materials.

C. The Revision of Senior High School Curriculum

In 1964, the revised curriculum standards were promulgated and new teaching materials for Mathematics, Physics, Chemistry and Biology were developed. The characteristics of these new materials are summarized as follows:

1) The modern conceptual patterns in thinking were developed as a guide of compilation of contents. The new courses were more experimental and more directly oriented towards problem-solving than conventional descriptive facts. The courses were designed to afford students an opportunity to explore, invent and discover and to develop an attitude of inquiry, to

1. Senior High School Curriculum Standard, Ministry of Educ., Taipei, Taiwan, 1971, pp.372-374.

experience experimentation and to guide them to their own conclusions.

2) The content of new teaching materials had been designated to bring science knowledge up to date in every possible way. It's purpose was not only to fit the students' aptitudes but also to increase their interests, and moreover, to stimulate able students to continue the study of science in college toward advanced research in the future.

3) There were, in addition to the text and the laboratory manual, a teachers' guide and laboratory guide through which the teacher could try to accomplish the purpose of effective teaching.

4) There were also audio-visual films to accompany the texts. Students often learned about subject matter through these media of instruction and whenever possible by directly observing phenomena and the methods of dealing with them. Texts, laboratory manuals, teachers' guides, equipment and films were therefore, employed to unify learning and teaching in science education.[1]

D. The Present Science Curriculum in Senior High School

The present senior high school science curriculum was revised in 1971. In the first school year students follow one course in Biology, three hours a week, consisting of two hours

1. Senior High School Curriculum Standard, Ministry of Educ., Cheng-chung Book Co., Taipei, 1971, pp.372-374.

of instruction and one hour laboratory work. There are also two field trips during the school year.[1] The course is required and is taught at the same level for all students. By the time students reach the second school year, they must decide whether to pursue studies in the Social Study Program or in the Natural Science Program.

The science program in the second school year provides for Chemistry at two levels. There are three hours per week for social science students and six hours for natural science students which includes laboratory work. The same applies to Physics in the third school year. There is a new required course, Earth Science, introduced for natural science students in their third school year. This course which includes lecture and laboratory is taught two hours per week.

One of the general aims of the present curriculum is to strengthen science education. The major points of emphasis in the sciences are as follows:[2]

1) the broaden the scope of science education by introducing Earth Science as a required course in the third school year.

2) To increase by one hour weekly both Mathematics and Chemistry courses at the second school year.

3) To improve the curricula of natural sciences according to current revisions of BSCS, CHEMS, and PSSC texts.

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1. Senior High School Curriculum Standard, Ministry of Educ., Cheng-chung Book Co., Taipei, Taiwan, 1971, pp.203-208.
2. Ibid., pp.400-418.

4) To increase optional courses in the terminal school year with two weekly hours of Mathematics, three weekly hours of Advanced Biology for the students interested in medicine and agriculture, and three weekly hours of Chemistry and Physics for students interested in science and engineering.

All new texts, laboratory manuals, teachers' guides and laboratory guides are compiled and approved by the Ministry of Education. The students have acess to reference work and periods of laboratory work are mandatory. Interspersed among these periods are industrial visits, conferences, science films and personal projects.

E. The Survey of Science Education in Senior High School

The evaluation of senior high school science education in Taiwan has been recently completed.[1] The survey was established by the Ministry of Education and was conducted through a committee which involved the collaboration of administrative staff and academic members, educators and specialists from universities and research institutes. Within the year and a half of planning, the committee has completed preparation of school visitation, data processing and investigation of science education. The science courses evaluated included Mathematics, Physics, Chemistry, Biology and Earth Science. The evaluation listed: teaching staff, methods of instruction, laboratory and management, curriculum,

1. The Central Daily News, Taipei, Taiwan, Jan. 22, 1978.

library, finance and continuing education.

1) Teaching Staff

The study showed that science teachers in Mathematics Physics, Chemistry and Biology were fairly well qualified and sufficiently experienced.[1] The only problem seen was the lack of adequate teachers to teach Earth Science. The reason for this lack was that the curriculum of Earth Science is related to many fields, such as geography, physics, chemistry, minerology and astronomy. It was recommended that a quality program should be developed by institutions for the preparation of teachers for this curriculum.

2) Methods of Instruction

In Taiwan, senior high school science teachers were for the most part enthusiastic and responsible.[2] Because the content of teaching materials and methods of instruction were influenced by the college entrance examination, teachers and students were under great pressure to prepare this examination. Most students concentrated their energies on memory and on recitation. The conceptual load was usually so heavy that there was little time and energy left for carrying out scientific activities. It was considered that this load would result in a loss of ability in creative thinking. Thus provision should be made for conducting scientific activities to cultivate student's

1. The Central Daily News, Taipei, Taiwan, Jan. 22, 1978.
2. Ibid.

interests and problem-solving abilities.

3) Laboratory

Other than Earth Science which was newly introduced to the curriculum, most senior high schools have laboratories equipment and facilities on a fairly adequate level for application of laboratory work and demonstrations. The only matter to be emphasized was that a great variety of apparatus and facilities should be replaced and supplied from time to time according to required needs.[1]

4) Science Curricula

The current science curricula were issued in 1971 and have been implemented for several years. Although the course objectives and contents were fairly constructive, it is inevitable that the curricula of today will not be the curricula of tomorrow. The evaluation of the present science curricula resulted and their reorganization was necessary in those instances in which the evidence indicated that the existing curricula were not effectively designed to accomplish the stated objectives for science education.[2] The development of satisfactory science curricula to meet both social and technological obligations is seen as one of the greatest challenges in the field of senior high school sciences.

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1. The Central Daily News, Taipei, Taiwan, Jan. 22, 1978.
2. Ibid.

5) Library

The results of the survey showed that there was a noticeable tendency among all schools of reference books and periodicals being limited and outdated. This lack was due to the majority of teachers who confined their teaching within the content of the texts and the college entrance examinations. Another factor was the student's lack of various types of science activities. Thus all schools of secondary education should have access to a number of new additional science books, project references, magazines and supplyhouse catalogues.

6) Finace

In the annual operating budget every school received a definite allotment for science equipment and supplies necessary for laboratories. The sums of money that are spent on science education today are much larger than those of a few decades ago, and there is a tendency that the cost will continue to increase in future. In order to make this type of investment more practical and effective, an appropriate budget should be planned through careful examination of the exact expenditures on various science courses and through reliable estimation of required costs for new units and courses.

7) The Continuing Education of Science Teachers

Since 1958 the Secondary School Teacher's Research

Centers have been set up in the National Taiwan Normal University and the Provincial Teachers' College for both long term (17 weeks) and short term (2-4 weeks) in Biology, Physics, Chemistry and Mathematics.[1]

The short term in-service training program offered on-the-job teachers new concepts, new teaching materials and methods for improving specific scientific accomplishments. The participants also shared experience with each other through discussions and assigned seminars.

The long term professional training program is designated for college graduates who wish to become secondary school teachers. Usually, these teachers are required to received 16 credits in education. If they teach in an area unrelated to their major field, they have to take 20 credits of academic courses in that field, in addition to 16 credits in education.

Furthermore, many science teachers are selected to travel abroad for advanced study every year. This travelling abroad is approved by the Ministry of Education through the selected recommendations of the schools, with the careful consideration of the environment, personnel and the science training program requirements. The National Science Council provides study grants.

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1. Education in Taiwan Province, Dept. of Education, Taiwan Provincial Government, 1974, Taichung, Taiwan, pp.19-20.

8) The Survey Consensus[1]

In accordance with the criteria listed above, the survey committee of science education of the secondary school arrived at the following consensus:

a) In regards to teaching staff, the Ministry of Education should firmly establish an on-the-job training program which would provide assistance to both individual teachers and school systems to facilitate the improvement of science teaching. Usually, the success of science education depends on the personal and scholarly qualified individual teacher.

b) Another proposal is to set up a fixed sabbatical schedule for the high school teachers by the Ministry of Education. The Ministry should also encourage the science teachers to pursue a greater participation in academic conferences and workshops by availing staff of the opportunities to attend.

c) Experience with research is essential to the science teacher who would share with his students a spirit of discovery. Excellence in research should be encouraged through financial aids or awards.

d) The content of instructional techniques should be organized into units. The science teacher must compose a lesson plan for each unit which would be insteresting, significant and useful to the learners. Meanwhile, the National Institute

1. The Central Daily News, Taipei, Taiwan, Jan. 22, 1978.

for Compilation and Translation should standardize and unify scientific terms for sciences, and should issue them to the school teachers as soon as possible. Moreover, the science teaching aids must be supplied with careful planning and good judgment.

4 - 3 Summary

In general, the science education of secondary schools in Taiwan may be summarized as follows:

1) Science is a basic part of general education for all students at the secondary level. There is a national exclusive curriculum standard which deals with Biology, Chemistry, Physics and Earth Science respectively at both junior and senior high school levels. The specific objectives for each subject, its basic content, and time allotment are uniform throughout Taiwan. This reveals the limited educational choice for local situations and for students' particular interests.

2) Science teaching in secondary schools in Taiwan improved and advanced considerably between 1960 and 1970. But many problems still remain, such as the large size of the class and laboratory group, lack of new developing facilities and supplies, insufficient time pressures, the predominance of descriptive content and the constraint of college entrance examinations. These problems eliminated the possibilities of

experimental work and scientific activities by students. Consequently, secondary science education in Taiwan is still, more or less, a reading and memorizing method of teaching.

3) Junior high school science is now in a period of readjustment and accelerated change. There is a great urgency to get started on the preparation of improved instructional materials for integrated sciences. The three-year integrated sequence of general science is to be implied and organized as in other countries.

4) The present science curricula have been carried out almost nine years for senior high schools. As there is no science curriculum that can be considered final and definitive, the necessity of continual revision of the curriculum is increasingly acknowledged. The Ministry of Education is now collecting the opinions from different sources and is trying to revise the science curriculum for effective learning of the discipline in the near future.

5) According to the survey, shortage of competent science teachers is still a problem as some teachers are not qualified or do not work effectively. Therefore, an intensive preservice and in-service training program should be provided to aid them in comprehending objectives of modern science education, in learning up-to-date science content, in using laboratory facilities, and in applying the inquiry and laboratory approach to the teaching of science.

6) For planning an effective science program, the following recommendations are vigorously offered:

a) The weekly hours of science courses should be reviewed and adjusted from time to time to accomplish the objectives of science education specified in every school year. Some provisions such as field trips, project work, guide study and extra-curricular scientific activities should be provided for students.

b) A good science program should be characterized by a variety of approaches rather than adherence to a single formula description of facts. Particularly, it involves an emphasis on investigation and inquiry with controlled practical work.

c) Both the science curricula and textbooks in use should be reviewed and revised by continuous updating at all levels, as time and situations require.

d) There must be special provisions for students who have a marked interest in and aptitude for science. This may take the form of individualized guided study, science club activities, appointments as teaching assistants, or special research work. To carry out this program, time, facilities, extra funds and supervisors should be provided. Also, the extensive and varied science curricula should be encouraged for the talented and more capable students.

e) In developing general science program, it is important to select the profound materials from Physics, Chemistry, Biology and Earth Science, and to explore new scientific investigations from time to time. This program will provide students with an opportunity to see the inter-relationships of the special scientific areas. Also, the program could be designed and extended the understandings that have already been developed. There should not, however, be undue repetition of subject content.

Fanally, the status of science education of secondary schools needs to be approached with care. Over-crowded classes, shortage of facilities, inadequately prepared teachers, inflexible curricula and out-of-date teaching content must be overcome in the future through the cooperation of administrative and professional organizations.

CHAPTER 5

CHEMISTRY TEACHING IN SECONDARY SCHOOL

The main objective of this chapter is to present chemistry teaching in Taiwan secondary schools during the thirty years between 1945 and 1975.

Beginning with a short description of the development of secondary chemistry teaching, some historical developments are outlined.

Firstly, the development of chemistry teaching in Taiwan will be examined prior to considering chemistry in junior high schools. This examination will include chemistry curriculum revision, content of texts and the most recent survey of junior high school chemistry teaching.

Chemistry teaching in senior high schools will then be presented. The traditional chemistry curriculum is discussed. In 1963, the reform of senior high school chemistry initiated a number of significant changes. The 1964 revision of chemistry curriculum was greatly influenced by both the CHEM Study and CBA Projects.

The reform of science education continued. In 1971, the new authorized curriculum in chemistry was reproduced under the UNESCO Pilot Project for chemistry teaching in Asia. With the evaluation of recent chemistry texts and the 1971 chemistry curriculum, the 1975 chemistry curriculum proposal was devised.

Finally, the chapter will conclude with a summary of chemistry teaching in Taiwan secondary schools from 1945 to 1975.

5 - 1 Development of Chemistry Teaching

Chemistry has been a part of the high school curriculum in Taiwan since the Chinese school system began in 1945. Also, this curriculum is viewed as contributing to general education and as compulsory at both junior and senior levels in the secondary school.

During post-World War II years improvements in science education were undertaken by the Ministry of Education. In December of 1948 a high school curriculum was issued and all the texts that had been used in wartime or before the war were revised or replaced.[1] In July 1962 another revised high school curriculum was proposed.[2] These proposed changes in curriculum resulted in updated content and new textbooks in the chemistry courses but did little to modify the traditional approach to chemistry teaching. The teaching of chemistry still stressed the acquisition of factual information from designed texts and teachers presented information with little or no experimentation or active personal involvement by the

1. Report of Senior High School Chemistry Teaching Material Study, Dept. of Chem., National Taiwan Normal Univ., Taipei, taiwan, 1975, pp.1-3.

2. Ibid.

students.

During the post-Sputnik years, the United States National Science Foundation went to considerable effort and expense to develop new science curricula and new approaches to science teaching. Two high school chemistry programs were proposed, namely: the chemical Bond Approaches (CBA), and the Chemical Educational Materials Study (CHEMS).[1] These two programs were based on experiment and on texts integrated with laboratory work and the use of teaching aids. The philosophy of these programs was that chemistry is a "process of inquiry", and that it continuously relates to experimental findings.[2] These modern programs represented a significant and substantial change in the approach to the teaching of chemistry in North America. The Ministry of Education in Taiwan recognized that this new inquiry approach had many merits that should be incorporated into the science curricula in its own country.

A reform was then initiated when the Ministry of Education and the Asian Foundation established a committee whose mandate was to examine and study the new inquiry type science programs and to make recommendations on their implementation in Taiwan secondary schools.[3] The committee's examination of the new inquiry programs in science included:

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1. McBryde, W.A.E., The CBA and CHEMS Program, High School Teachers' Mag., 1(4), 1966, U.S.
2. Pode, J.S.F., CBA & CHEMS: An Appreciation, J. Chem. Educ. 43, 98(1966), U.S.
3. Senior High School Curri. Standard, Ministry of Education, Cheng-chung Book Co., Taipei, Taiwan, 1971, pp.372-374.

the New Mathematics Program, Biology Science Curriculum Study (BSCS), Chemical Educational Materials Study (CHEMS), Chemical Bond Approaches (CBA) and Physical Science Study Committee (PSSC).[1] In March 1964 the new chemistry course of study with the content and spirit of the CHEM Study was proposed and implemented in some senior high schools. Prior to the total implementation of the new chemistry program, selected professors from universities visited high schools and institutes in the United States. They participated in conferences, seminars and workshops on the modern approaches to the teaching of chemistry. These educators returned and were responsible for the re-training of the local chemistry teachers. Courses in the new chemistry program were offered at the teacher training institutes and at in-service training centers during the summer of 1964 throughout Taiwan.

Since 1964 the textbooks of the CBA and CHEMS have been translated into Chinese and published. Although both programs were well organized and explicit, they were not totally suitable for Taiwan high school students because of differences in educational background. In order to correct the differences in the chemistry program, the Ministry of Education decided to revise the program to accommodate students' needs and backgrounds. A committee of university professors, high school teachers and administrators was

1. Senior High School Curri. Standard, Ministry of Education, Cheng-chung Book Co., Taipei, Taiwan, 1971, pp.372-374.
2. Report of Senior H.S. Chem. Teaching Materials Study, Dept. of Chem., National Taiwan Normal Univ., Taipei, 1975, pp.1-3.

established to accomplish this task. The committee examined the three versions of the original CHEM Study text:

Pimental: Chemistry: An Experimental Science, 1963

Cotton, Lynch: Chemistry: An Investigative Approach, 1968

O'Conor, Davis, et al: Chemistry: Experiments and Principles, 1968

In addition, the new chemistry program in Japan and the Nuffield Chemistry Program in England were also examined. Being cognizant of the needs and background of the students and the new development of the modern chemistry programs in foreign countries, the committee developed a new chemistry curriculum. It was issued as a part of "Senior High School Curriculum Standard" which was published in 1971 in Taiwan.[1]

The 1971 chemistry curriculum incorporated and modified versions of the CHEMS and CBA programs. The texts, laboratory workbooks and teachers' guides were written according to this official curriculum. There were nine Chinese texts published together with laboratory manuals from 1972 to 1975.[2]

After the implementation of the 1971 chemistry curriculum, many high school chemistry teachers criticized the program because they felt that it was too advanced and too quantitative. In 1973 the Ministry of Education with the cooperation of the Department of Chemistry, National Taiwan Normal University, initiated a study to examine

1. Report of Senior H.S. Chem. Teaching Material Study, Dept. of Chem. National Taiwan Normal Univ., Taipei, 1975, pp.1-4.
2. Ibid., pp.51-52.

these criticisms of the chemistry program. A comparative study of the chemistry texts used in the United States, Japan, Europe and Taiwan was undertaken. This study resulted in the provision of new chemistry curriculum in 1975. The study also indicated that chemistry programs and texts would have to be continuously revised to insure that the courses remained in step with the time.

5 - 2 Chemistry in Junior High School

Over a thirty year period of time the junior high school chemistry program has not changed radically in either purpose or content. During the first three years after World War II an introductory chemistry course was given three period a week in the second school year (Grade 8). In 1948 a revised junior high school curriculum was introduced by the Ministry of Education. A new 'Physics-Chemistry' course in a two-year sequence was then developed. It was a combination of physics and chemistry as a "Sandwiched" course in science. Topics were interwoven and treated as a unified theme. This course which had been in existence from 1948 to 1967 was offered in the second and third year, given four periods a week.[1] During this period the rapid increase in the number of students enrolled in the secondary school classes became larger and the teaching load became heavier both

1. Public Junior H.S. Curri. Standard, Ministry of Educ., Cheng-chung Book Co., Taipei, Taiwan, 1968, pp.329-359.

quantitatively and qualitatively. But neither the increase in size of classes nor the heavier teaching load helped in improving science instruction. Such circumstances produced more textbook teaching and less laboratory activity.

In 1968 a new compulsory education program which integrated the elementary and lower secondary school programs in a nine-year sequence was developed. Because the original Physics-Chemistry course did not form a coherent whole it was reorganized and separated into two courses as 'Chemistry' and 'Physics'. Since then, both chemistry and physics have been concurrently offered in the second and third year and given two periods each every week. This introductory chemistry course includes knowledge of prime importance to human life. The syllabus for teaching chemistry appeared to capture the students' interests and stimulate their desires for further study. The following chemistry curriculum for junior high school was issued by the Ministry of Education in 1968.

5-2-1 Chemistry Curriculum for Junior High School[1]

A. Objectives

1. Directing the student to obtain the basic chemistry knowledge relevant to the daily life by observation and experimentation and to stimulate his interest in self-learning.

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1. Public Junior H.S. Curri. Standard, Ministry of Educ., Cheng-chung Book Co., Taipei, Taiwan, 1968, pp.109-112.

2. Inspiring the student to discover the problems of chemistry in daily life, to solve them by scientific methods and to cultivate good scientific attitudes.
3. Guiding the student to design simple chemistry experiment and the materials needed for developing his latent creative competence.
4. Introducing the artificial chemical products used in daily life in order to induce the student to have an expectation to improve his environment and a better living.

B. Time Allotments for Chemistry Course

1. Two periods per week in second and third school years (Grade 8 and 9).
2. Lectures and laboratory work should be properly organized.

C. Chemistry Outline[1]

1. Separation of Matter
2. The Heat Effect on Matter
3. Air
4. Combustion
5. Elements
6. Water
7. Preparation of Chemicals from Rocks

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1. Public Junior H.S. Curri. Standard, Ministry of Educ., Cheng-chung Book Co., Taipei, Taiwan, 1968, pp.110-111.

8. Preparation of Chemicals from Ocean
9. Atoms
10. Preparation and Investigation of Hydrogen Chloride
11. The Periodic Table
12. Atomic Structure of Elements
13. Solids, Liquids, and Gases
14. Acids, Bases, and Salts
15. Electrolytes
16. Relative Number of Particles in Chemical Reaction
17. Catalyst and Rate of Reaction
18. Chemical Resources in Earth Crust

D. Implementation Guideline[1]

1. The chemistry course of study includes 18 units. The textbook is written flexibly in terms of changing the order of the scheme, but the schedule should be carefully worked out as a possible logical teaching sequence.
2. At the end of each unit there are review questions provided to help students understand the concepts and principles.
3. The texts have to provide various charts and tables to make students' learning more effective and pleasant.
4. Great emphasis is placed on experimentation as the

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1. Public Junior H.S. Curri. Standard, Ministry of Educ., Cheng-chung Book Co., Taipei, Taiwan, 1968, p.112.

basis for teaching. Lecturing and the "spoon feeding" method have to be avoided.

5. Teachers have to arrange time for discussion with students in order to increase their ability of using chemistry concepts and principles to solve the problems surrounding their daily life.
6. Teachers should organize field trips visiting factories, farms and mine areas relating to the various applications of chemistry.
7. Teachers should pay attention to students' differences, and give individual instruction to the slow learners and encourage superior students to conduct science projects and further readings outside the classroom.

The junior high school chemistry curriculum implemented in 1968 and the old Physics-Chemistry texts were eliminated. The content of the new chemistry course was directed towards a basic knowledge of chemistry and the discovering and solving the chemistry problems in everyday life. The new texts were compiled by the Committee on Compilation and Publication of High School Standard Textbooks. These texts were delegated to the National Institute of Compilation and Translation. The following units of authorized chemistry textbooks defined the scope of the course and provided the teacher with a possible teaching sequence.

5-2-2 Chemistry Textbook for Junior High School

The Junior High SChool Chemistry, volume 1 -- Second School Year, First Semester (Grade 8).[1]

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1. Public Junior H.S. Chem. Texts, National Institute of Compilation & Translation, Taiwan Book Co., 1972, 4th.ed.

Chapter 5 Elements

5-1 How Can You Name and Classify Elements?

5-2 What is the Difference Shown in Chemical Reaction of Oxygen?

Chapter 6 Water

6-1 What is the Composition of Water?

6-2 How Can You Prepare Hydrogen in Laboratory?

6-3 Does Hydrogen Possess Reduction Reaction?

6-4 How Important is the Water to Human Life?

6-5 How Can You Change Hard Water into Soft Water?

* * * * * *

The Junior High School Chemistry, volume 2 -- Second School Year, Second Semester (Grade 8).

Chapter 7 Preparation of Chemicals from Rocks

7-1 How is Iron Prepared from Iron Minerals?

7-2 How is Copper Prepared from Copper Minerals?

7-3 How is Lime Prepared from Limestone?

7-4 How is Aluminum Prepared from Bauxites?

Chapter 8 Preparation of Chemicals from Ocean

8-1 What are the Resources in the Sea Water?

8-2 What Happens on the Electrolysis of Sea Water?

8-3 How is Iodine Prepared from Sea Water?

Chapter 9 Atoms

9-1 How Can You Know that the Matter is Made of Particles?

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The Junior High School Chemistry, volume 3 -- Third School year, First Semester (Grade 9).

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The Junior High School Chemistry, volume 4 -- Third School Year, Second Semester (Grade 9).

21-2 Are All the Chemical Reactions Exothermic?

21-3 How Can the Heat of Reactions be Measured?

Chapter 22 Organic Compounds

22-1 How Can You Test the Carbon and the Hydrogen in the Organic Compounds?

22-2 What is the Fermentation?

22-3 What is the Esterification?

Chapter 23 Polymers

23-1 What is the Structure of the Polymers?

23-2 What are the Plastics?

23-3 Can Starch Change into small Molecules?

Chapter 24 Chemical Resources

24-1 What are the Metal Minerals (I) -- Gold and Silver?

24-2 What are the Metal Minerals (II) -- Tin, Antimony, Mercury and Tungsten?

24-3 What are the Non-Metals -- Coal, Petroleum and Asbestos?

An examination of the junior high school chemistry textbooks revealed that the teaching content had been considerably updated and was relevant to students' daily life. All concepts and principles were derived from experimental observation as the basis for knowledge of chemistry.

5-2-3 The Survey of Junior High School Chemistry Teaching

The 1968 chemistry curriculum has been implemented over ten years. A recent survey on public junior high school science education was conducted by the National Science Council and Taiwan Provincial Kao-hsiung Teachers College. The findings of this survey dealing with the chemistry program represented the following results.[1]

1) The Content of Chemistry Curriculum and Texts

In accordance with the survey, most junior high school chemistry teachers proposed that the content of chemistry should first emphasize the learning ability and interest of the students, basic chemistry knowledge and needs of individual and society as shown in Table 22 of Chapter 4.

As to the quantity of materials and the sequence of the curriculum, most chemistry teachers pointed out that they were appropriate as shown in Table 30.

Table 30. The Opinion on the Sequence of 1968 Junior High School Chemistry Curriculum[2]

Opinion	% of Junior H.S. Chem. Teachers
Appropriate	60
Partially Inappropriate	29
Inappropriate	11

1. National Science Council, Public Junior H.S. Science Educ. Survey, Taiwan, 1974.

2. Ibid., p.96.

The treatment of laboratory work in the 1974 texts differed from that in the conventional texts. The students were encouraged to do experiments before they read the lesson. In this manner they were expected to get an experimental basis for understanding the concepts. According to the survey more than half of chemistry teachers preferred that the laboratory work should be compiled at the beginning of each unit. The following Table 31 indicates that 57% of junior high school chemistry teachers prefered laboratory experiment listing before the lessen, 31% prefered laboratory experiment listing behind the lesson; and only 8% favored a text with a separated laboratory manual.

Table 31. Coordination of Chemistry Lab. and Lesson[1]

Coordination of Lab. and Lesson	% of J.H.S. Teachers
A text and a lab. manual book	8
Lab. experiment listed before the lesson	57
Lab. experiment listed behind the lesson	31
No opinion	2
Other	2

The table showed that most chemistry teachers prefered conducting experiments before delivering lecture. In actuality, however, the majority of teachers followed the conventional

1. National Science Council, Public J.H.S. Science Educ.Survey, Taiwan, 1974, p.99.

approach, the approach of texts, occasionally giving demonstration or group experiment. Undoubtedly, there were a number of reasons, such as the large size of the class, insufficient time and the lack of assistants and facilities. About one third of teachers expected that chemistry be scheduled three periods a week instead of two at present and that it was desirable to have one double period for laboratory work and discussion.[1]

2) Method of Instruction

Although the inquiry approach was recommended in the guidelines of the curriculum implementation, very few chemistry teachers used this method. From the survey, the following tables show the opinions of both teachers and students on the teaching method of chemistry.

Table 32. Teaching Method of Chemistry in Junior High School Performed by Teachers[2]

Methodology	% of Junior H.S. Teachers
Systematic lecturing	66
Class discussion	14
Supervised study	12
Project activity	8

1. National Science Council, Public J.H.S. Science Educ. Survey, Taiwan, 1974, p.115.

2. Ibid., p.105.

Table 33. TEACHING METHOD OF CHEMISTRY REFLECTED BY JUNIOR HIGH SCHOOL STUDENTS[1]

Methodology	% of J.H.S. Students
Generally lecturing	70.3
Occasionally discussion	12.6
Supervised study	14.5
Occasionally learning by doing	2.6

These two tables show that the methods most commonly used in junior high school chemistry teaching were lecturing and text-recitation. Discussion and supervised study were used occasionally, and laboratory work was apparently at minimum.

The survey of laboratory work and demonstration in chemistry teaching may be shown as follows:

Table 34. LABORATORY WORK CARRIED OUT BY JUNIOR HIGH SCHOOL CHEMISTRY TEACHERS[2]

Lab. work in one semester for grouping students	% of teachers
over 10 times	3.5
11 - 15 times	9.8
6 - 10 times	40.4
1 - 5 times	38.1
None	8.2

1. National Science Council, Public J.H.S. Science Ed. Survey, Taiwan, 1974, p.105.
2. Ibid., p. 109.

Table 35. Demonstration Carried Out by Junior High School Chemistry Teachers[1]

Demonstration	% of Teachers
Very often	66.3
Occasionally	30.8
Not at all	2.9

Table 36. Laboratory Facilities Provided in Junior High School[2]

Laboratory facilities	% of Schools
Chem. lab. available	42.3
All purpose laboratory	36.5
No laboratory	21.2

The survey provided evidence that there were more lecture-demonstration and less laboratory instruction in the teaching of chemistry in junior high schools and that unfortunately 21.2% of junior high schools were without laboratories.

Table 37. Students' Opinion of the Chemistry Laboratory[3]

Opinion	% of Students
Interesting, and learning a lot	32.5
Interesting, but no chance to do	40.0
Interesting, but doing very little	24.5
Interesting, but wasting time	1.0
No laboratory work at all	2.0

1. National Science Council, Public J.H.S. Science Educ. Survey Taiwan, 1974, p.110.
2. Ibid., p.111.
3. Ibid., p.111.

According to the data given in the above tables, a large percentage of students were interested in doing laboratory work but had less opportunities to perform the experiment during the laboratory period due to the large size of the classes and the lack of laboratory facilities. The survey also showed that the average grouping of students was between 6 to 8 as shown in Table 23 of Chapter 4. It is difficult for good chemistry teaching to go on in classes that are too large for group working because of limited space, time and facilities for students to perform the experiments themselves.

Tyler found that science students taught with emphasis on verbalism forgot about 80% of what they had learned in one year.[1] What to teach in chemistry and how to teach it effectively should be based on experimental evidence. Thus it was considered important to stress the development of chemistry laboratory facilities in junior high schools in order to let students engage in direct activity in which they can gain the knowledge of science. These concerns were considered urgent because not only would the students' interests be aroused but also effective methods for science teaching would be built.

As to the use of visual aids in teaching chemistry, as shown in Table 24, Chapter 4, most teachers were still giving demonstration-lectures and lectures with blackboards, only 23.4% of science teachers in total used movies, slides,

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1. Ralph W. Tyler, What High School Pupils Forget, Ohio State Univ., Educ. Research Bulletin 9, Nov. 1930, pp.490-492.

models and charts in teaching chemistry.

In addition, the teachers' guide that was matched with each text provided detailed instruction for the textual materials, the guide of laboratory work and demonstration, the answers to exercises and problems and the supplementary materials. Unfortunately, only about one half of junior high school chemistry teachers ever used the guide as shown in Table 25, Chapter 4.

3) Teaching Staff

With respect to the method of instruction, many teachers were unable to handle the inquiry approach in the teaching of chemistry. The survey of the sources of junior high school chemistry teachers as shown in Table 26, Chapter 4, indicates that only 8% of them are the graduates from the Normal University and teachers colleges majoring in chemistry. The vast majorities of teachers only had a major or minor in one or more of the sciences in universities and colleges. It was evident that well-qualified chemistry teachers were not available in adequate numbers. Thus even with a well-prepared course of study, the lack of qualified teachers to implement study programs prevents an adequate transmission of knowledge. Therefore, for the immediate future, two urgent needs became increasingly evident for the preparation of better science teachers: one is the development of an instructional program in science that will serve effectively and uniquely the needs of prospective science teachers, and the other is the development of continuing education programs for the professional science teaching discipline.

5 - 3 Chemistry in Senior High School

Chemistry in the senior high school was offered in the second school year (Grade 11) at two levels. This was due to the growing recognition of the need for making better provisions for students of varying abilities and interests, and for those individuals who had different goals. For the social science program, Chemistry was presented as part of general education and was intended to prepare students to be scientifically informed citizens. It was hoped that students would apply what they had learned in chemistry to everyday life. For the natural science program, a course in chemistry was directed toward training the future scientists by laying a sound foundation and motivation to continue their study of science. The course was also one of the requirements for their college entrance examination. Since the students in the natural science majors displayed a special interest in sience, they were given both a deeper and a more comprehensive knowledge of the different aspects of theoretical chemistry and its applications.

5-3-1 Chemistry Curriculum for Senior High School

1) The Traditional Chemistry Curriculum

The establishment of a set of standards for a course of study in senior high school chemistry was the work of the Chemistry Curriculum Committee of the Ministry of Education in Taiwan. During the period of 1945-1960, the efforts of the Curriculum Committee were concerned with standards and minimum essentials rather than innovation. Thus the early curriculum standards listed the topics and experiments of the entire course by giving only the knowledge toward college requirements rather than serving critical thinking. It was quite common to find a series of units with little regard for sequence. The chemistry units were organized around material substances such as oxygen, hydrogen and certain elements. The subject matter included the study of both metals and non-metals, and the attention was given to the atmosphere, the manufacturing processes, the familiar substances and a certain number of laws and facts of chemistry. Thus, as far as possible, the presentation was to be inductive.

Since 1960, there has been a growing tendency to organize the units around concepts, principles and generalizations. In 1962, the revised chemistry curriculum was issued by the Ministry of Education for both the natural and the social progams. The revision appears to have been built upon a theoretical approach but still with strong emphasis on certain substances and with less emphasis on investigation and inquiry.

Table 38. 1962 Senior High School Chemistry Curriculum[1]

I. The Objectives of Senior High School Chemistry	
For Natural Science Program:	For Social Science Program:
1. To acquire systematical knowledge of chemistry by means of explanation of the fundamental theories as the basis for advanced study.	1. To stimulate students' learning interests by informing matters with their chemical changes which are important in daily living.
2. To stimulate students' learning interests by informing matters with their chemical properties which are related to daily living.	2. To learn the methods and techniques of investigation of changes in matters and to encourage students to solve the living problems by using acquired chemistry knowledge.
3. To learn the methods and techniques of investigation of changes in matters and to encourage students to solve the living problems by using acquired chemistry knowledge.	3. To develop an understanding a correlation between chemistry and political, economic, social problems by introducing the theoretical and technological achievements of modern chemistry and its influences to society.
4. To develop an understanding of application of the scientific methods by presenting the modern concepts and theories resulting from the experimental discoveries.	
5. To inspire students to contribute in science in future by introduction of modern chemistry to both theoretical and technological achievements in chemistry.	
II. Time Allocation	
Five weekly hours including laboratory work in the second school year (Grade 11).	Three weekly hours including laboratory work in the second school year (Grade 11)

1. Senior High School Curriculum Standard, Ministry of Education, Cheng-chung Book Co., Taipei, 1962.

III. Chemistry Outline

For Natural Science Program:

1. Introduction (Matter and Energy)
2. Structure and classification of matter
3. Oxygen and ozone
4. Air, nitrogen, and the noble gases
5. Hydrogen
6. Water and hydrogen peroxide
7. Examples of chemical calculation
8. Gas behavior
9. Solutions
10. Electrolysis of salt solution
11. The halogens
12. The periodic law and the atomic structure
13. Sulfur and its compounds
14. Ammonia and oxyacids of nitrogen
15. Oxidation and reduction
16. Solutions of electrolytes
17. Chemical equilibrium
18. Acids, bases, and salts
19. Phosphorus, arsenic, antimony, bismuth and their compounds
20. Carbon and its simple compounds
21. Hydrocarbons
22. Fuels
23. Alcohols, ethers, aldehydes, ketones
24. Organic acids and esters

For Social Science Program:

1. Introction (Matter and Energy)
2. Structure and classification of matter
3. Oxygen and ozone
4. Air
5. Hydrogen
6. Water and hydrogen peroxide
7. Gas behavior
8. Solutions
9. Electrolysis of table salt
10. The halogens
11. The periodic law and the atomic structure
12. Oxidation and reduction
13. Solutions of electrolytes
14. Sulfur and its compounds
15. Ammonia and oxyacids of nitrogen
16. Chemical equilibrium
17. Acids, bases, and salts
18. Phosphorus, arsenic, antimony, bismuth and their compounds
19. Carbon and its simple compounds
20. Hydrocarbons
21. Alcohols, ethers, aldehydes, and ketones
22. Organic acids and esters
23. Carbonhydrates
24. Proteins and nutrition

(Continued)

25. Carbonhydrates
26. Proteins
27. Silicon and boron
28. Alkali metals and their compounds
29. Copper, silver, gold and their compounds
30. Alkaline earth metals and their compounds
31. Zinc, cadmiun, mercury, and their compounds
32. Aluminum and its compounds
33. Tin, lead, and their compounds
34. Chromium, manganese and their compounds
35. Iron, cobalt, nickel and their compounds
    platinum
36. Nuclear chemistry

Laboratory Work:

1. Training for basic lab. operation
2. Physical changes and chemical changes
3. Preparation and properties of oxygen
4. Preparation and properties of nitrogen
5. Preparation and properties of hydrogen
6. Solutions and solubility
7. Prepn. and properties of hydrochloric acid
8. Preparation and properties of chlorine
9. Bromine and its compounds
10. Iodine and its compounds
11. Allotropics and properties of sulfur
12. Prepn. and properties of hydrogen sulfide
13. Prepn. and properties of sulfur dioxide

(Continued)

25. Silicon and boron
26. Alkali metals and their compounds
27. Copper, silver, gold, and their compounds
28. Alkaline earth metals and their compounds
29. Zinc, cadmiun, mercury, and their compounds
30. Aluminum and its compounds
31. Tin, lead, and their compounds
32. Chromium, manganese and their compounds
33. Iron, cobalt, nickel and their compounds;
    platinum
34. Nuclear chemistry

Laboratory Work:

Teacher demonstration

14. Prepn. and properties of sulfuric acid
15. Prepn. and properties of ammonia
16. Oxides of nitrogen
17. Prepn. and properties of nitric acid
18. Acids, bases, salts; Neutralization and hydrolysis
19. Compounds of phosphorus and arsenic
20. Properties of carbon
21. Prepn. and properties of carbon dioxide
22. Destrutive distillation of wood and coal
23. Alcohols
24. Organic acids and esters (acetic acid)
25. Prepn. of soaps and their cleaning action
26. Properties of carbonhydrates
27. Sodium, potassium, and their compounds
28. Copper, silver, and their compounds
29. Magnesium, calsium, barium, and their compounds
30. Hard water, soft water and softening hard water
31. Zinc, mercury, and their compounds
32. Aluminum, lead, tin and their compounds
33. Iron and its compounds
34. chromium, manganese and their compounds
35. Electronative series of metals
36. Oxidation and reduction

2) The Reform of the Chemistry Curriculum

The chemistry curriculum innovation initiated in 1963 was the result of the dissatisfaction of both the scientific and educational communities with the quality of chemistry education at the senior high level. It was also a result of the CBA and CHEMS projects in the United States being closely observed by educational authorities which aroused the interests of educators and many chemistry teachers in Taiwan. The authorities realized that the senior high chemistry curriculum needed to be revised, re-examined and reformed. In 1964 the second revision of the chemistry curriculum was initiated and new teaching materials were developed. The revisions were patterned after and influenced by both CBA and CHEMS projects. The texts of CHEMS and CBA were translated and the Chinese versions were published.[1] The revised chemistry courses were based on modern principles of science teaching with more emphasis on the student's active participation and less on his rote-learning. It was quite significant that the adaptation of CHEMS and CBA was being introduced to replace traditional chemistry teaching.

During 1965-66, the UNESCO Pilot Project for Chemistry Teaching in Asia organized an International Working Group which consisted of chemistry teaching reform specialists, outstanding chemical research scientists plus twenty Asian chemistry teachers from teaching training institutions of fourteen Asian

1. Chen, C.T. & Wong, C.S., Senior High School Chemistry, vol.1 & 2, Tung-Hwa Book Co., Taipei, Taiwan, 1964.

countries. Taiwan was one of the participants.[1] This International Working Group provided a useful system as a channel for transferring to the Asian teachers some of the experience on curriculum reform gained in major projects such as the Nuffield Chemistry Project, the CHEM Study and CBA Projects. Futhermore, UNESCO invited each participating country to organize a National Study Group. The most important function of this Group was to work in linking the International Working Group of the Pilot Project with individual or group effort in each country directed toward carrying on curriculum reform, writing new textbooks and conducting in-service courses for chemistry teachers. In 1971 the new authorized curriculum in chemistry was reproduced as shown in Table 39.

The efforts for the design of this new senior high school chemistry curriculum were aimed firstly at reorienting chemistry from a descriptive science to an experimental science in keeping with modern developments in teaching chemistry. Secondly, the efforts aimed at reducing the number of topifs conventionally covered in chemistry courses to concentrate upon the development of a better understanding in modern thinking regarding the science of chemistry. The laboratory work for the new chemistry course was more experimental and more directly oriented toward problem-solving than the conventional laboratory exercises. Thisnew chemistry course was intended to be more meaningful and more challenging to the high school tudents than the conventional course had been.

1. See Appendix II.

Table 39. 1971 SENIOR HIGH SCHOOL CHEMISTRY CURRICULUM[1]

I. The Objectives of Senior High School Chemistry

For Natural Science Program:	For Social Science Program:
1. To develop an understanding of the fundamental theories and the systematical knowledge of chemistry through laboratory work for the basis of advanced study.	1. To develop an understanding of the fundamental theories of chemistry through the experimental activities in such a way to provide that the pupils may obtain chemistry knowledge necessary in their lives.
2. To develop an appreciation of the scientific method application by the procedure of building concepts and theories of general chemistry.	2. To inspire pupils to investigate the daily living problems related to chemistry, and to solve them by using scientific methods for adapting to the modern living environment.
3. To train pupils to gain the ability in dealing with chemistry problems in order to meet the needs in modern lives.	3. To introduce chemical products related to industry, agriculture, and mineralogy to provide that the pupils may understand and recognize the importance of chemistry in the national economic development.

II. Time Allocation

Six weekly hours including lab. work in the second school year (Grade XI).	Three weekly hours including lab. work in the second school year (Grade XI).

1. Senior High School Curriculum Standard, the Ministry of Educ., Cheng-Chung Book Co., Taipei, Taiwan, 1971, pp.169-192.

III. Chemistry Outline

(Table 39 continued)

For Natural Science Program:

1. The activities of science
2. The basic generalization
3. The gas phase
4. The condensed phase
5. The structure of atom
6. The electron configuration & the periodic table
7. The configuration of gaseous molecules
8. The configuration of the solid and liquid
9. The rates of chemical reactions
10. Equilibrium in chemical reactions
11. Oxidation and reduction
12. The halogens
13. The third row elements in the periodic table
14. Elements of group I & II in the periodic table
15. The first row transition elements
16. Nuclear chemistry
17. The chemistry of carbon compounds
18. Biochemistry

Laboratory Work:

1. Scientific observation and description
2. Changes on heating solids & determination of melting point
3. The masses of equal volumes of gases
4. Copper - Silver nitrate reaction

For Social Science Program:

1. Introduction
2. The gas phase
3. The condensed phase
4. The atomic structure & the periodic table
5. Chemical bonding
6. The chemical reaction and chemical equilibrium
7. Acids, bases, and salts
8. Oxidation-Reduction reaction
9. Hydrocarbons and their derivatives
10. Saccharides, fats, and proteins
11. Nuclear chemistry
12. Important chemical industry

Laboratory Work:

1. Changes on heating solids & determination of melting point
2. Burning candle
3. Quantitative measurement of heat effect
4. The masses of equal volumes of gases

Laboratory Work: (continued)

5. A study of chemical reations
6. Conservation of mass during chemical change
7. Quantitative analysis of the reations of metals with hydrochloric acid
8. Reaction volums between two solutions of given concentration
9. Building models
10. Properties of cis- and trans- isomers
11. The atoms or the ionic packing in crystals
12. Heat of reaction
13. A study of reaction rates
14. Chemical equilibrium & Le Chateller's Principle
15. Determination of the solubility product constant of the silver acetate solution
16. Quantitative analysis of Ag^{+}, Hg^{++}, Pb^{++} etc.
17. Determination of H^{+} by using indicators
18. Acid-base titration
19. Reactions in a cell
20. Oxidation-Reduction reaction
21. A study of corrosion of iron
22. Moles of copper, silver and their moles of electrons relationship during electrolysis
23. Chemical properties of hydrocarbon and alcohols
24. Derivatives
25. Qualitative analysis by using solubilities of compounds of Group II elements
26. Some chemistry of iodine
27. The electrolysis of aqueous KI to manufacture I_2
28. The Third row elements
29. The separation of transition element ions with an anion exchange resin
30. Paration of a complex salt

5. Quantitative analysis of the reaction of magnesium with hydrochloric acid
6. The volume change during the reaction in two solutions with given concentration
7. Building models
8. The additives of heating effect and the heating effects of acid-base reaction
9. Reaction rates
10. Determination of H^{+} by using indicators
11. Neutralization--with quantitative titration
12. Oxidation-Reduction reaction
13. Electrolysis (potassium iodide solution) and eletro-plating (silver plating)
14. Reactions of hydrocarbons and alcohols
15. Monosaccharides reactions and multisaccharides hydrolysis
16. Destructive distillation of coal

There were two different levels of chemistry content with respect to the students' capabilities and interests. The chemistry curriculum for students in the Natural Science Program stressed "thinking like scientists" and the derivation of many basic concepts based on laboratory experiences, and the mathematical understanding that was an integral part of the curriculum. The chemistry curriculum for the Social Science Program was for non-science oriented students who studied chemistry with the emphasis on the scientific process, scientific theories and the kind of scientific evidence related to the daily living.

3) The Development of the Recent Chemistry Curriculum

Since the 1971 chemistry curriculum was established a great need became evident for modern high school chemistry texts to accomodate the up-dated program. In response to this need nine texts for local schools together with appropriate laboratory manuals and teachers' guides were written by Taiwan chemistry teachers during 1972-1975.

A. Teachers' Criticisms

After the implementation of the 1971 chemistry curriculum, both the content of chemistry courses and the methods for teaching them have been criticized by students and teachers alike as inappropriate. They felt that:

a. Chemistry content was too theoretical and too abstract.

b. There was too much calculation and memorization.

c. The content was too excessive and complicated to be completed in one year of study.

d. To keep up the teaching schedule, teachers often skipped laboratory work and demonstration.

e. The content was irrelevant to everyday life.[1]

The criticisms were invaluable in determining changes introduced in the current revision. It was probable that the abilities of chemistry students were somewhat lower than ten years previous and that teachers were not well-prepared for the up-dated curriculum.

As the movement to a "theoretical approach" to chemistry reached a high point, the chemistry curriculum became based less on fact and more on principles and generalizations. Moreover, most of the major changes in the chemistry curriculum in the last decade (1965-1975) had paid insufficient attention to the changing attitudes, aspirations and abilities of students. It was felt that an improved chemistry program should be developed. As a result of these criticisms several attempts were made to establish both appropriate content and methology for chemistry teaching in senior high schools.

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1. Report of Senior High School Chemistry Teaching Material Study, Department of Chemistry, National Taiwan Normal Univ., pp.1-2.

B. Evaluation and Study

Perhaps the most challenging aspect of any curriculum improvement project is the evaluation of current programs. Thus in 1973, the Ministry of Education in Taiwan commited the Department of Chemistry of the National Taiwan Normal University to be in charge of a comparative study of senior high school chemistry teaching materials.[1]

The combined effort of chemistry professors and teachers resulted in three projects: 1) to study current chemistry programs in the United States, England and Japan, 2) a review of nine Chinese chemistry texts, 3) a proposal for senior high school chemistry curriculum.

a) The Study of Current Chemistry Programs

The comparative study of the CHEM Study Project, the Nuffield Chemistry Project and the Japanese new Chemistry Program indicated recent trends in high school chemistry. The new trend in chemistry education was seen as both a way to include inquiry and as a body of information which was obtained through scientific enquiry. It was a "theoretical approach" based on experiements undertaken in the spirit of investigation. It was considered necessary to provide the opportunity for exploration so that students could develop disciplined creative thinking and would be aware of the role that chemistry plays in modern life.[2]

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1. Report of Senior H.S. Chem. Teaching Materials Study, Dept. of Chemistry, National Taiwan Normal Univ., Taipei, 1975, p.2.
2. Ibid.,pp.4-50.

b) The Review of Present Chemistry Texts [1]

The review of nine commercial chemistry textbooks published between 1972-1975 indicated some of major topics of chemistry found in the texts as shown in Table 40 on p.165. This gave curriculum planners an excellent summary of topics and sub-topics in chemistry courses. The study revealed a great similarity concerning major topics because all nine texts were written to accomodate the 1971 chemistry curriculum. There were certain differences, however, in the sequence and organization of the content. It was recognized that the texts had been strongly influenced by the CHEM Study curriculum. Most textbooks were presented theoretically and conceptually, stressing the need for students to think like scientists and to have a mathematical understanding of the topics studied.

Such curricula were effective in presenting concepts and skills to natural science students but they did not meet the needs of the majority of social science students who lacked such understanding. Such students encountered considerable difficulty in chemistry and developed a deep antipathy towards the subject. It was clear that a need existed for curriculum revision in senior high school chemistry.

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1. Report of Senior High School Chemistry Teaching Materials Study, Dept. of Chemistry, National Taiwan Normal University, Taipei, Taiwan, 1975, pp.51-148.

Table 40. THE COMPARISON OF RECENT CHEMISTRY TEXTS WITH THE 1971 CHEM. CURRICULUM[1]

hapter (I)	1971 chem. curri.(II)	Wong's text	Tao's text	Ling's text	Yeh's text	Cho's text	Chang's text	Lu's text	Hsu's text	Chan' text
1	Activities of science	same as (I)(II)	same as (I)(II)	same as (I)(II)	Intro- duction	Introduction	Introduction	same as (I)(II)	Introduction	Chemistry: an experi- mental science
2	Basic genera- lization	-	-	-	same as (I)(II)	same as (I)(II)	same as (I)(II)	-	Atomic theory	Atomic concept: a scientific model
3	gas phase	-	-	-	-	Gas: the dynamic theory of gas	Gas: the dynamic theory of gas	-	Gas phase	Chemical formula & chemical reaction
4	Condensed phase	-	-	-	-	Condensed phase: liquid & solid	Condensed phase: liquid & solid	-	same as (I)(II)	Gas phase: dynamic theory of gas
5	Atomic structure	-	-	-	-	Atomic structure & periodic table	same as (I)(II)	-	-	Condensed phase: liquid & solid
6	Electron configu- ration & periodic table	-	-	-	-	Configuration of atom	Chemical bonding	-	Classification of elements--the per- iodic table	Atomic structure
7	Configuration of gaseous molecules	-	-	-	-	Bonding in gas molecules	Chemical reaction & rate of reactions	Rates of chemi- cal reaction	same as (I)(II)	Electron configuration & periodic table
8	Configuration of solid & liquid	-	-	-	-	same as (I)(II)	Chemical equilibrium	Equilibrium of chem. reaction	Bonding in condensed phase	Bonding in gas molecules
9	The rate of chem. reactions	-	-	-	-	Energy change & rate of chem. reactions	Acids and bases	Bonding in gas molecules	Heat effect and rates of chemi- cal reactions	Bonding in solid and liquid molecules
10	Equilibrium in chem. reactions	-	-	-	-	Chemical equili- brium	Oxidation and reduction	Configuration of solid & liquid	Chemical equili- brium	Energy effect of chemical reactions
11	Oxidation and reduction	-	-	-	-	same as (I)(II)	Hydrogen & the repre- sentive elements	same as (I)(II)	same as (I)(II)	The rate of chem- ical reactions
12	The halogens	-	-	-	-	-	Non-metal elements & Inert gases	-	-	Equilibrium of chem. reaction
13	3rd row elements in periodic table	-	-	-	-	-	Transition elements	-	The 3rd row elements	Acids, bases & salts
14	Elements of group (I) and group(II)	-	-	-	-	-	Nuclear chemistry	-	same as (I)(II)	Oxidation & reduction
15	The 1st row tran- sition elements	-	-	-	-	The 4th row tran- sition elements	Carbon compounds	The 4th row tran- sition elements	Transition elements	The halogens
16	Nuclear chemistry	-	-	-	-	same as (I)(II)	Bio-chemistry	same as (I)(II)	same as (I)(II)	The 3rd row elements in periodic table
17	Carbon compounds	-	-	-	-	-		-	Organic chemistry	The 1st and 2nd group elements
18	Bio-chemistry	-	-	-	-	-		-	same as (I)(II)	The 1st row transi- tion elements
19										Nuclear chemistry
20										Chemistry of carbon compounds
21										Bio-chemistry

1. Report of Senior H.S. Chemistry Teaching Materials Study, Dept. of Chemistry, National Taiwan Normal Univ., Taipei, Taiwan, 1975, p.55.

c) The Recent Chemistry Curriculum Proposal

The 1975 chemistry curriculum proposal was devised by the study group for both natural science and social science students, as shown in Table 41 on pp.167-174. It hoped to arouse and foster the insterest of students in learning chemistry. Considerable changes were made from the 1971 chemistry curriculum. The content was integrated and 18 chapters in the 1971 chemistry curriculum were reduced to 16 chapters in the 1975 chemistry curriculum proposal. The first section of the curriculum laid a foundation for the rest of the course. Scientific activities, the atomic structures, energy levels of electrons and chemical bonding in gases, liquids, and solids were included. An extended part of the curriculum was devoted to the important chemical principles which included energy, rate, equilibrium of chemical reactions, solubility, oxidation and reduction and chemical calculations. The following section included the classification of elements and discussed the halogens, a representive row and group of the periodic table and the transition elements. The course concluded with the descriptive chemistry of carbon, bio-chemistry and nuclear chemistry. The last chapter entitled "Main Chemical Industries" was designated for the social science program dealing with the applicability and practicability of the content.[1]

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1. Report of Senior High School Chemistry Teaching Materials Study, Department of Chemistry, National Taiwan Normal University, Taipei, Taiwan, 1975, pp.149-156.

Table 41. 1975 Senior High School Chemistry Curriculum

I. The Objectives of Senior High School Chemistry

For Natural Science Program:

The objectives of chemistry curriculum are the training of scientific methods, the development of systematical chemistry concepts and the cultivation of good scientific attitudes through investigative activities of matter and energy. These should give students a good background for advanced chemistry research.

To achieve these objectives the students must be able to:

1. discover the problems of nature in an active way and to solve them by applying scientific methods.
2. develop an understanding of the fundamental theories and concepts of chemistry through experimental activities and apply these concepts and theories automatically.
3. became good citizens with scientific attitudes through the carrying out of chemistry experiments.
4. Understand the relation between chemistry and life, and to stimulate the desires of improving human lives and meet the needs of modern living.

For Social Science Program:

The objectives of chemistry curriculum are the training of scientific methods, the development of systematical chemistry concepts and the cultivation of good scientific attitudes through investigative activities of matter and energy. These should enable students to adapt to their modern living environment and to be science-educated citizens

To achieve these objectives the students must be able to:

1. discover the problems of nature in an active way and to solve them by applying scientific methods.
2. develop an understanding of the fundamental theories and concepts of chemistry through experimental activities and apply these concepts and theories to daily living.
3. become good citizens with scientific attitudes through the carrying out of chemistry experiments.
4. understand the relation between chemistry and life, and the importance of chemistry to national economic construction and defense.

(Continued)

Table 41 Continued

For Natural Science Program:	For Social Science Program:
II. Time Allocation:	
Six weekly hours including lab. work in the second school year (Grade Xl).	Three weekly hours including lab. work in the second school year (Grade Xl).
III. Chemistry Outline:	
1. Chemistry and scientific activities	1. Chemistry and scientific activities
1.1 Chemistry and human life	1.1 Chemistry and human life
1.2 Scientific methods	1.2 Scientific methods
1.3 Scientific attitudes	1.3 Scientific attitudes
1.4 Scientific measurement and accuracy	Expt. 1. Observation and description of burning candle
Expt. 1. Observation & description of burning candle	
Expt. 2. Scientific measurement & accuracy	
2. The basic generalization of chemistry	2. The basic generalization of chemistry
2.1 Properties and changes of matter	2.1 Properties and changes of matter
2.2 The atomic theory	2.2 The atomic theory
2.3 Atom and molecule	2.3 Atom and molecule
2.4 Compound and element	2.4 Compound and element
2.5 Atomic weight, molecular weight, mole	2.5 Atomic weight, molecular weight, mole
2.6 Chemical formulas and equations	2.6 Chemical formulas, equations, chemical calculations
2.7 Chemical calculations	
Expt. 3. Chemical changes & physical changes	Expt. 2. Chemical changes & physical changes
Expt. 4. Determination of the molecular size	Expt. 3. The quan. relations in chemical changes
Expt. 5. The quan. relations in chemical changes	

(Continued)

Table 41 Continued

3. The gas phase	3. The gas phase
3.1 The common properties of gases	3.1 The common properties of gases
3.2 The gas law	3.2 The gas law
3.3 The kinetic theory of gases	3.3 The gas equations and their applications
3.4 Avogadro's law	3.4 The kinetic theory of gases
3.5 Ideal gases and real gases	Expt. 4. The gas law
Expt. 6. Pressure-volume relation for gas	
Expt. 7. Temperature-volume relation for gas	
Expt. 8. The diffusion rate of Ammonia & Hydrogen chloride	
Expt. 9. Molecular weight of gases	
4. The condensed phase	4. Air
4.1 Phase change & phases in equilibrium: vapor pressure, heat of vaporization, heat of melting	4.1 The composition of atmosphere
4.2 Solution: Expressing the composition of solutions, solubility	4.2 Nitrogen, oxygen, carbon dioxide, water vapor, noble gases
4.3 Increasing of boiling pt. & decreasing of freezing pt.	Expt. 5. The components of air
4.4 Crystals	
Expt.10. Determination of boiling point of solution	
Expt.11. Melting of solid substances	
Expt.12. Determination of molecular weight by decreasing of freezing point	
5. The atomic structure & the periodic table	5. The condensed phase and solution
5.1 Experimental facts for existing of atoms	5.1 The phase change
5.2 The model for the atom	5.2 Solution: composition, solubility, concentration
5.3 Atomic number, mass number, isotopes	5.3 Crystals
5.4 Spectrum, energy level of electrons	
5.5 The obitals	

(continued)

Table 41 Continued

5.6 The electron configuration	Expt.6. Boiling point of solution
5.7 The periodic table	Expt.7. Melting of solid
5.8 The noble gases	
Expt.13. The characteristics of the cathode rays (teacher demonstration)	
6. Chemical bonding	6. The atomic structure & the periodic table
6.1 Ionic bonding	6.1 The model for the atom: atomic number, mass number, isotopes
6.2 Covalent bonding: non-polar & polar covalent bonding	
6.3 Hydrogen bonding	6.2 The configuration of the electrons
6.4 Network structure	6.3 The periodic table
6.5 Structure of metals	Expt.8. The characteristics of the cathode rays (teacher demonstration)
6.6 Van der Waals forces	
Expt.14. Polar and non-polar compounds	
Expt.15. Packing of atoms & ions in crystals	
7. Chemistry of water	7. Chemical bonding
7.1 Physical properties of water	7.1 Covalent bonding
7.2 The structure of water	7.2 Ionic bonding
7.3 Common properties of solutions	7.3 Van der Waals forces
7.4 Water pollution	7.4 Hydrogen bonding
7.5 Water purification	Expt.9. Polar & non-polar compounds
Expt.16. Determination of osmosis pressure	
Expt.17. Tests for water pollution	
Expt.18. Water purification by ion-exchange method	

(Continued)

Table 41 Continued

8. The rates of reactions & chemical equilibrium	8. Chemistry of water
8.1 The heat of reaction	8.1 Physical properties of water
8.2 Factors affecting the rates of reactions: nature of reactants, concentration, temperature, catalysts	8.2 The structure of water
	8.3 Water pollution
8.3 The reversible reactions	8.4 Hard water & softening hard water
8.4 Equilibrium in chemical reactions	Expt.10. Water purification by ion-exchange method
8.5 The dynamic nature of equilibrium	
8.6 Application of the law of chemical equilibrium	
Expt.19. Determination of heat of reaction	
Expt.20. Factors affecting the rate of equilibrium	
Expt.21. Chemical equilibrium & Le Chatellier's principle	
9. Solubility equilibrium	9. The rates of reactions & chemical equilibrium
9.1 Solubility: an equilibrium	9.1 The heat of reaction
9.2 Factors affecting solubility	9.2 Factors affecting the rates of reactions
9.3 The solubility product constant, Ksp	9.3 The reversible reaction & chemical equilibrium
9.4 The common ion effect	
9.5 Application of solubility product	9.4 The dynamic nature of equilibrium and industrial applications
Expt.22. Determination of the solubility product of Silver Acetate	
	Expt.11. The heat of reaction
	Expt.12. The dynamic nature of chemical equilibrium
10. Acids and bases	10. Acids, bases, salts
10.1 Dissociation of water	10.1 The electrolytes: strong electrolytes & weak electrolytes
10.2 Operational definitions of acids and bases	
10.3 Neutralization of acids and bases	10.2 The common properties of acids

(continued)

Table 41 Continued

10.4 The strengths of acids and bases	10.3 The common properties of bases
10.5 The new conceptual definitions for acids & bases	10.4 The acid-base neutralization & salts
10.6 The buffer solution	Expt.13. The electrolyte's solutions
10.7 Hydrolysis of salts	Expt.14. Acid-base titration
Expt.23. Determination of acidity & basicity in soln.	
Expt.24. Acid-base titration	
11. Oxidation and reduction	11. Oxidation and reduction
11.1 The electro-chemical cells	11.1 The electro-chemical cells
11.2 Oxidation-reduction & half-cell reaction	11.2 The voltage of an half-cell
11.3 The voltage of an half-cell	11.3 Oxidation numbers & their applications
11.4 Oxidation numbers	11.4 Electrolysis: Electroplating, Electro-metallurgy, Electro-molding
11.5 Balancing oxidation-reduction equations	11.5 The lead storage cell
11.6 Electrolysis & its applications: Faraday's law, Electroplating, Electro-metallurgy, Electro-molding	Expt.15. The replacement reaction in solution
Expt.25. The electro-chemical cell	Expt.16. The electro-chemical cell
Expt.26. Oxidation and reduction	
Expt.27. Quan. relations between moles of metal deposited & moles of electrons in electrolysis	
12. The chemistry of atmosphere	12. Inorganic chemistry
12.1 The composition of atmosphere	12.1 The 3rd row elements of the periodic table
12.2 Nitrogen, Oxygen, Carbon dioxide, vapor	12.2 The halogens and their compounds
12.3 Air pollution	12.3 The alkali metals, the alkaline earth metals
Expt.28. Determing the component of air by laboratory experiment	Expt.17. The properties of the 3rd row elements of the periodic table
Expt.29. Tests for ingredients of polluted air	Expt.18. The characteristics of the halogens

(Continued)

Table 41 Continued

13. Inorganic chemistry	13. Chemistry of carbon and carbon compounds
13.1 The 3rd row elements of the periodic table	13.1 Carbon: The allotropic forms
13.2 The halogens	13.2 Hydrocarbons and their derivatives: Alkane, Alkene, Alkyne, Benzene, Alcohol, Phenol, Ether, Aldehyde, Ketone, Acid, Ester.
13.3 The alkali & the alkaline earth metals	Expt.19. The properties of hydrocarbons
13.4 The transition metals	Expt.20. The preparation of esters
13.5 The chemistry of complexes	
13.6 The important metal elements & their compounds	
Expt.32. The separation of transition metal ions with an anion exchange resin	
Expt.33. Preparation of complex salts	
14. Chemistry of carbon and carbon compounds	14. Carbonhydrates, fats, proteins
14.1 Carbon	14.1 Monosaccharides & disaccharides
14.2 Sources of carbon compounds	14.2 Starch & cellulose: paper, rayon
14.3 Hydrocarbons and their derivatives	14.3 Fats: soaps, detergents
14.4 Polymers and their uses	14.4 Proteins
14.5 Chemical industry of petroleum	Expt.21 Properties of monosaccharides and disaccharides
Expt.34. Chemical properties of alkanes & alkenes	Expt.22. The preparation of soap
Expt.35. Preparation & properties of esters & amines	
15. Bio-chemistry	15. Nuclear chemistry
15.1 Saccharides	15.1 The natural radio-active elements
15.2 Starch and cellulose	15.2 Radio-active decay
15.3 Fats	15.3 Man-made elements
15.4 Proteins	15.4 Nuclear energy: nuclear reactor, nuclear power plant
15.5 Nucleic acid	15.5 Radioactive isotopes & their peaceful applications
15.6 Enzymes	
15.7 Metabolism	

(Continued)

Table 41 Continued

Expt.36. Reduction property of glucose
Expt.37. Hydrolysis of sucrose
Expt.38. Properties of starch
Expt.39. Preparation of soap

16. Nuclear chemistry
16.1 The natural radioactive elements
16.2 Radioactive decay
16.3 Nuclear reactions
16.4 Nuclear energy: nuclear reactor and nuclear power plant
16.5 The transuranium elements
16.6 Application of radioactive isotopes
Expt.40. Photographic effect of radioactive isotopes

Expt.23. The photographic effect of radioactive rays (teacher demonstration)

16. Main chemical industries
16.1 Fuel industry: Petroleum, catalytic cracking, heat cracking, coke, coal gas
16.2 Alkali industry: electrolysis of sea water sodium hydroxide, sodium carbonate, chlorine, bleach powder, plastic.
16.3 Acid industry: sulfuric acid, hydrochloric acid
16.4 Fertilizer industry: fixation of air, ammonia, ammonium sulfate, urea, phosphorus fertilizer, potassium fertilizer
16.5 Construction materials: cement, glass, steel
16.6 Defense industry: explosives, toxic gases

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1. Report of Senior High School Chemistry Teaching Materials Study, Dept. of Chemistry, National Taiwan Normal University, Taipei, Taiwan, 1975, pp.149-156.

The chemistry curricula for both natural science and social science programs developed by the study group in 1975 had the following distinctive features:

i. The chemistry curricula were conceptual and structural approaches to an intellectual discipline based on experimentation.

ii. They were presented in a planned sequence of selected contexts to develop students' understanding.

iii. They could be evaluated in terms of not only the objectives of chemistry in general but also in terms of the immediate behavioral objectives.

iv. Knowledge and inquiry processes were integrated intellectually and experimentally. In principle, the topics and experiments were interwoven and treated as unified themes.

v. The laboratory work was completely revised in order to fit the new pattern of the course, and in most cases experiments were more relevant.

vi. The chemistry curricula presented chemistry as it is today. Great emphasis is placed on students' living environment and the daily life.

5-3-2 Comparison of the CHEM Study with the 1971 and 1975 Chemistry Curricula in Taiwan

Considering that the CHEM Study Project had extensively influenced senior high school chemistry, the question arose: " were there any differences between the CHEM Study and the current 1975 chemistry curriculum in Taiwan?"

There were four published texts relevant to the CHEM Study in the United States. The original CHEM Study text was published in 1963, and three revised versions of texts followed subsequently:

Author	Textbooks
1.Pimental	Chemistry: An Experimental Science, 1963
2.Cotton, Lynch	Chemistry: An Investigative Approach, 1968
3.O'connor, Davis Haenisch McNab McLellan	Chemistry: Experiments & Principles' 1968
4.Parry, Tellefser Steiner, Dietz	Chemistry: Experimental Foundations, 1970

The following Table 42 will provide a comparison of the CHEM Study texts in the United States with the 1971 and 1975 chemistry curricula in Taiwan.

Table 42. COMPARISON STUDY OF CHEM TEXTS WITH THE 1971 AND 1975 CHEMISTRY CURRICULUA[1]

	CHEM 1963	Cotton 1968	O'connor 1968	Parry 1970	1971 chem. curri.	1975 chem. curr
I. Scientific Activities & Uncertainty	1	1,2	1	1	1	1
II. Atomic Structure & Chemical Bonding						
1. Particle Models, Molecules, Atoms	2345	3,4	2345	2345	2,3,4	2,3
2. Electrons, Nuclear Atomic Models	5614	5,6,7	6,7,8	6,7,8	5	5
3. Energy Level of Electrons	15	8	9,16	15	6	5
4. Chemical Bonding: Gas Phase	16	9	10	16	7	6
Liquid & Solid Phase	17	10	17	17	8	6,
III. Chemical Reactions						
1. Energy Change of Reaction	3,7	12	3,11	3,9	9	8
2. Rate of Reaction	8	13	12	10	9	8
3. Chemical Equilibrium	9	14	13	11	10	8
4. Solubility	10	15	-	12	10	9
5. Acids and Bases	11	16	14	13	10	10
6. Oxidation and Reduction	12	17	15	14	11	11
7. Chemical Calculations	13	11	-	-	2,3,4	2,3
IV. Classification of Elements						
1. The Halogens	19	18	19	20	12	13
2. The Alkline Earth Metals	21	19	-	20	14	13
3. The 3rd Row Elements	20	20	-	19	13	13
4. The 4th Row Elements	22	21	20	21	15	13
5. The 6th, 7th Row Elements	23	22	-	-	16	13
V. Special Chemistry						
1. Carbon Compounds(Organic Chem.)	18	23	16,18	18	17	14
2. Bio-chemistry	24	24	18	22	18	15
3. Nuclear Chemistry	7,23	7,22	21	7,9	16	16
4. Earth & Space Chemistry	25	25	-	23	-	12

1. Report of C.N.S. Chem. Teaching Materials Study, Dept. of Chem. National Taiwan Normal Univ., Taipei, Taiwan, 1975. and C.H.S Curri Standard, 1971.

The previous table indicates that the contents of both the CHEM Study texts and two Taiwan chemistry curricula were very similar. The significant differences lay in the sequence and the number of chapters. The distribution of main topics were analyzed as follows:

Table 43. The Distribution of Main Topics of CHEMS Texts and Two Taiwan Chemistry Curricula

Main Topics	Number of Chapters					
	CHEMS 1963	Cotton 1968	O'connor 1968	Parry 1970	1971 curri.	1975 curri.
I. Scientific activities and uncertainty	1	2	1	1	1	1
II. Atomic structure and chemical bonding	10	8	11	10	7	6
III. Chemical reactions	8	7	6	7	6	7
IV. Classification of Elements	5	5	2	4	5	1
V. Special Chemistry	5	5	4	5	3	4

According to the data both in texts and curricula, section I occupies the least chapters. Section II and III occupy the most chapters. Section IV and V have less chapters than Section II and III. CHEMS texts have more chapters than two Taiwan chemistry curricula. The 1975 chemistry curriculum of Taiwan has the least chapters but covers all topics as shown in Table 42.

5-3-3 Improvement of Teaching Methodology

The success of a chemistry course depends not only upon its content but also on the teaching methods employed. Since the CHEM Study project was introduced into Taiwan high schools in 1964, the method of instruction has changed considerably. High school science teachers were encouraged to adopt the 'guided discovery' or 'inquiry' approach. This meant that the learning of chemistry was to be oriented toward laboratory experiments. The movement caused certain problems. Large number of teachers had to be retrained to handle the new approaches and good laboratory facilities were essential for implementing these approaches.

Although the revised chemistry curricula were being used in high schools and new texts strongly based on student laboratory experiments were provided, laboratory facilities could not be installed rapidly and teachers were not sufficiently qualified to offer the modern curricula. These lacks created dissatisfaction among high school students who studied chemistry.

1. Training of Chemistry Teachers

One of the urgent needs for a new chemistry teaching program was the supply of well-trained teachers who were qualified to teach the new courses. The Ministry of Education in Taiwan therefore set up and implemented a program for in-service training of science teachers. Taiwan has a rather unique system in that the science in-service training center is affliated with the National Taiwan Normal University and Teachers Colleges which controlled by the Ministry of Education and subsidized by the Provincial Department of Education.

The building of the center required laboratories, a library, workshops for the production of teaching materials, and classrooms for physics, chemistry, biology and earth sciences. The center was equipped with experimental facilities needed in high schools aswell as certain research instruments. The staff at the center were drawn from each science department of the teachers training institutions. The high school science teachers learned to familiarize themselves with the new curricula, texts, laboratory manuals, teachers' guides and science information.

There were also short term seminars, conferences, or workshops on new teaching methods and selected topics given by the National Taiwan Normal University and Teachers Colleges. An annual meeting was also held by the Chemistry Society of Taiwan. All these developments aroused sufficient teacher's interest to modernize chemistry teaching at all school levels.

For the training of prospective teachers, a five-year training program is now given by the teacher training institutes. Graduates of the faculty of science or engineering who want to become teachers are now given an additional one-year program to learn science curricula, teaching materials and methodology.

2. Laboratory Facilities, Texts and Teaching Aids

Another difficulty in Taiwan high schools is insufficient laboratories, equipment and technicians. This is due to an increasing number of students and the limited budget. However, a comprehensive range of equipment for laboratory purpose is now provided annually by the Ministry of Education and local educational agencies.

Between 1965-1975 a number of chemistry textbooks, laboratory manuals and teachers' guides were written for use in Taiwan high schools. All of these texts will soon be revised to keep pace with the 1975 chemistry curricula.

With such emphasis on modern approaches to teaching chemistry in these years, the national Institute of Educational Materials has prepared various audio-visual teaching aids. These aids include films, filmstrips, slides, tapes and charts concerned with chemistry teaching. For example, certain American films such as those made as part of the CHEM Study project have been translated into Chinese and distributed to various high schools in Taiwan.

There are also a number of commercial products now appearing on the market including various sets of models, charts and slides. This phenomenon is an attempt to lead to a greater efficiency in the teaching of high school chemistry.

5 - 4 Summary

The chemistry teaching during 1945-1975 in Taiwan may be summarized as follows:

1. The aims of chemistry teaching have been refocused with the intention that students should understand as opposed to simply memorize the facts of chemistry.

2. The curricula of junior and senior high school chemistry have been brought up to date.

3. Chemistry is now being taught in schools with a greater concern for the spirit of inquiry, the use of an experimental approach, the relevance of the subject to everyday life and the intellectual stimulus that it can provide for students.

4. It is now acknowledged that a frequent retraining of teachers is essential.

5. A considerable number of new experiments have been developed, replacing many old-fashioned and irrelevant ones.

6. Chemistry teachers now have available a wide range of teaching techniques.

7. There is a current tendency in junior high schools towards the integration of separate science courses (Biology, Chemistry and Physics) into one "General Science" course.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

The preceding chapters have dealt with the origin and condition of general education, the status of secondary science programs and the aspect of high school chemistry teaching in Taiwan during the period of 1945 to 1975. It is the purpose of this chapter to summarize the previous chapters as follows.

6 - 1 General Education

In oder to accelerate the development of human resources, Taiwan has been greatly concerned with general education.

1) Education in Taiwan has transformed society from a predominantly agricultural economy to a high level of industry.

2) Both the educational system and its development are administered and controlled exclusively by government agencies at three levels, Central, Provincial and Local.

3) Educational policies are established by the Ministry of Education of the Central Government. These policies reflect the decisions of teachers and administrators as well as the

the society.

4) The present educational trend in taiwan is to provide education and training for every individual to the extent of his or her ability. This is considered as a national investment that will reap profitable returns. Traditional concepts of education for the elite that accentuate the education of a talented few are generally fading.

5) The current demand for education in the fields of science and technology in Taiwan is greater than ever before. At the same time, there is an increasing awareness of the importance of spiritual and moral education to strenthen Chinese cultural heritage.

6) Constitutional expenditures for educational programs, scientific studies and cultural activities in Taiwan may not be less than 15% of the national budget, 25% of the provincial budget and 35% of the local budget annually.

7) Since the end of World War II, secondary education in Taiwan, as elsewhere in the world, has undergone changes of great significance involving quantitative and qualitative reforms. Free education has been offered to all students since 1968. This hasbeen instituted to meet the rapidity of scientific and technological changes at various social strata. Traditional educational concepts have been changed in consideration of the increasing number of industrial occupations.

8) The school curriculum is uniquely authorized by the Ministry of Education. Junior high school and elementary school curricula in Taiwan are organized in a nine-year sequence, emphasizing character building, citizenship training and practical knowledge so as to facilitate further schooling and/or employment. Curricula for senior high schools are divided into two sections at the end of the first school year. These are the 'Social Science' and 'Natural Science' programs. The curricula also emphasize vocational and technical training in addition to the basic subjects for the preparation of post graduate employment. In general, secondary school curricula have shifted from theoretical to more practical aspects of education.

9) The latest educational statistics issued by the Ministry of Education in August 1978, shows the educational improvements that occurred between 1950 and 1977 in Taiwan as follows:[1]

	School Year	
	1950	1977
i) The percentage of the full-time enrollment in the elementary schools to the total schooling age (6-12) children	79.98%	99.97%
The average number of students per teacher	36.35	29.18
The average class size	51.75	46.52

1. Central Daily News, International edition, August 29,1978. Taipei, Taiwan, p.1.

	School year 1950	School year 1977
ii) The percentage of the total number of the full-time students to the total population	14%	26.8%
iii) The percentage of the enrollment in different levels to the total number of students:		
a) Students in elementary schools/total number of students	86%	51.29%
b) Students in secondary schools/total number of students	11.4%	34.57%
c) Students in colleges & universities /total number of students	0.6%	6.8%
d) Students in other educational institutes/total number of students	2.0%	7.32%

10) The following information may provide a concept of educational progression in Taiwan as compared with that of Québec and Canada in 1974:

	Taiwan [1]	Québec [2]	Canada [3]
i) Population (1000)	15,382	6,081	22,095
ii) Total No. of students in ele. and sec. schools	3,840,286	1,544,731	5,684,598
Total No. of teachers	118,862	79,044	274,104
Students/teacher ratio	32.31	19.54	20.74
Students/population ratio	24.6%	25.40%	25.72%

1. China Year Book, 1975, China Publishing Co., Taipei, Taiwan, p.142 and pp.243-248.
2. and 3. Canada Year Book, 1975, Statistics Canada, Ottawa, p.164, and pp.301-302.

	Taiwan[1]	Québec[2]	Canada[3]
iii) Enrollment in colleges and universities	179,665	262,368	992,499
Students/population ratio	1.15%	4.31%	4.4%
iv) Total expenditure on education(US$1,000,000)	394.58	2824.5	9635.2
Educational expenditure per capita(US$)	25.32	464.48	436.08
Average per capita income	697	4675	5197
Educational expenditure per capita/capita income	3.63%	9.93%	8.39%

As illustrated by the above table, classes in Taiwan are significantly larger than those in Québec and Canada. This is greatly due to the lack of available capital. As shown, the total expenditure on education in Taiwan is less than one twentieth of that in Canada. This is particulary alarming when one considers the proximity of their total populations. One effect of this discrepancy of funding is evident upon examination of the student/population ratio of enrollment in colleges and universities. The ratio in Taiwan is less than one fifth of that in Canada. Clearly, a great deal more time and money must be devoted to education in Taiwan if the government wishes to approach the quality of education of other developed nations.

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1. China Year Book, 1975, China Pub. Co., Taipei, Taiwan. pp. 243-248. p.211, p.185.
2. and 3. Canada Year Book, 1975, Statistic Canada, Ottawa. pp.301-302, pp.1016-103[illegible].

6 - 2 Science Education

In Taiwan, the development of science education has been one of the government's main aims.

1) There is a national set of curricular standards which deal with Biology, Chemistry and Physics respectively at both junior and senior high school levels. The specific objectives for each subject, their contents and their time allocations are uniform throughout Taiwan.

2) The junior high school science curriculum is currently being readjusted. The Ministry of Education believes that there is great urgency in commencing to prepare instructional materials for the teaching of integrated science in junior high schools. The three-year general science program will be organized along similar lines to that of North America.

3) In order to improve the current senior high school science program, the Ministry of Education is trying to implement the elective system replacing the existing system at the beginning of the second school year. The elective courses include: language, mathematics, natural sciences, social sciences, industrial arts and professional technology.[1]

4) Intensive pre-service and in-service training programs are direly needed in Taiwan. Through these training programs, science teachers will be helped in comprehending

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1. Central Daily News International edition, Sept. 11, 1978. taipei, Taiwan, p.1.

objectives of science education, in learning current science contents, in using laboratory facilities and in applying the inquiry approach to the teaching of science.

6 - 5 Chemistry Teaching

1) Chemistry curricula at both junior and senior high school levels have been brought up to date.

2) The aim of chemistry courseses is focused on the relevancy of the program to the students' environment. There is a growing realization that content selection should be related to local conditions.

3) Chemistry teaching methods show a greater concern for the spirit of inquiry and the use of an experimental approach. Science teaching in Taiwan has been slower to adopt these approaches as they suffer from insufficient laboratorie and equipment and a shortage of well trained teachers.

4) The major contributions of laboratory work result from the opportunities for manipulation that are provided to each student. Most schools in Taiwan have average groupings of four to eight students in chemistry laboratory work. In such groups, non-agressive students are often excluded from the learning process. Careful planning is therefore needed to provide worthwhile activities for each student in larger groups.

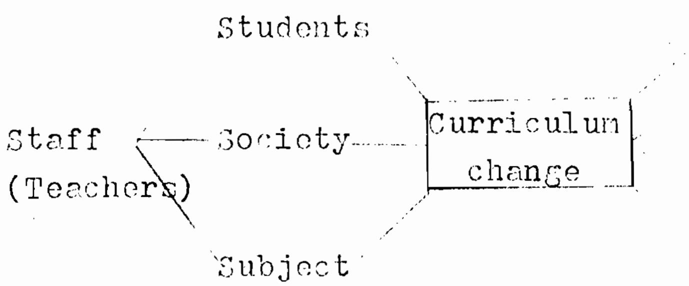
6 - 4 Recommendations

Based on the conclusions of this study, some recommendations are suggested as follows:

1) Science programs must allow for continuity in change. Courses of study should never remain fixed but always subject to modification and constant revision. It is the role of teachers to interpret the aspirations of students, the needs of society and the changing nature of their subject to produce a new curriculum. The following Figure 7 shows the factors affecting curriculum change and the stages of producing curriculum change.[1]

Figure 7. The Factors Affecting Curriculum Change and The Stages of Producing Curriculum Change

Factors affecting the curriculum(The four S'S



Stages of producing curriculum change (The four A'S)

Aims

Action(Teaching method and content)

Assessment

Adjustment(Evaluation and changes to the other 3A's)

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1. Daniels, D.J. New Movements in the Study and Teaching of Chemistry, Temple-Smith, London, 1975,p.260.

2) Provisions must be made for gifted students as well as slow learners.

3) The good science teacher must be prepared to use a variety of teaching methods; and one of his primary functions is to select an appropriate methodology for a given situation.

4) Every science program requires provision for an annual budget for the purchase of laboratory equipment and supplies, references, magazines and audio-visual teaching aids.

5) The three-year general science program in junior high school will be organized by the Ministry of Education in the near future. The following suggestions are offered:

a. The three-year general science program should be built upon the science experiences that children have in the elementary school. It should deepen and extend the understandings already developed without undue repetition.

b. In the teaching of general science, students should explore a few specific areas selected from Biology, Chemistry, Physics and Earth Sciences. This exploration leads students to see the interrelationships of the special science areas to develop an understanding of the principles and concepts associated with the various areas of science.

c. A good science program is characterized by a variety of approaches: demonstrations, discussions, laboratory experiments, field trips, the use of audio-visual aids, project work, student research, the use of community resources and science club activities.

d. The general science program should be flexible in adapting to local circumstances and in dealing with invididual interests and abilities of the student.

6) Chemistry teaching should follow the 'guided discovery' approach. The successful application of the guided discovery process involves the understanding of the following aspects:

a. The role of the teacher to guide discovery.

b. Student discovery in the laboratory.

c. Evaluation of the instructional conditions--to determine both the initial observation and terminal report of the students.

d. Levels of sophistication: the teacher evaluates the students' nature at three levels suggested by SCHWAB:[1]

i) At the simplest level, the material can pose problems and describe ways and means by which the student can discover relations he does not know from his books.

ii) At the second level, problems are posed by the manual but methods as well as answers are left open.

iii) At the third level, problems as well as answers and methods are left open.

e. Post-laboratory discussion: the teacher leads the class to examine and to discover other possible topics related to the experiment.

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1. Joseph J. Schwab, The Teaching of Science As Enquiry, Harvard University, Cambridge, Mass., 1964, p.55.

f. Discovery in the classroom: a spirit of independence from the teacher in learning should be created.

g. Formulation of 'Thought Pattern': chemistry students may investigate the concepts by the exploration of collected data. The science program of the Scottish Department of Education presents the following 'Thought Pattern' as shown in Table 44. The application of thought pattern to CHEMStudy experiment(s) will be listed in Appendix III.

Table 44. The Formation of Concept 'Thought Pattern' Thinking [1]

In Comprehending Knowledge	In Application of Knowledge	In Analysis Synthesis and Evaluation of Knowledge
Observing	Rearranging	Justifying
Comparing	Relating	Assuming
Classifying	Explaining	Inferring
Summarising	Predicting	Imagining
Interpreting	Estimating	Inventing
Discriminating		Discovering
Illustrating		Generalising
Extrapolating		Hypothesising
		Testing & Reassessing Hypotheses
		Judging

In view of the information provided in this study, the readers may increase their understanding of the science education and chemistry teaching of Taiwan secondary schools from 1945 to 1975. At most, this attempt represents only a

1. Science Program of the Scottish Department of Education, Edinburgh.

small fraction of what might and should be done in this area. There is a continuous need for research in the field of science curriculum planning at all levels of education.' One important question remains to contemplate : "What kinds of citizens do we wish our schools to produce?" This is a question tomorrow's curriculum reformers cannot ignore.

APPENDIX I

THE CONSTITUTION OF THE REPUBLIC OF CHINA

(Adopted by the National Assembly on December 25, 1946, promulgated by the National Government on January 1, 1947 and effective from December 25, 1947)

The National Assembly of the Republic of China, by virtue of the mandate received from the whole body of citizens, in accordance with the teachings bequeathed by Dr. Sun Yat-sen in founding the Republic of China, and in order to consolidate the authority of the State, safeguard the rights of the people, ensure social tranquility, and promote the welfare of the people, do hereby establish this Constitution, to be promulgated throughout the country for faithful and perpetual observance by all.

Section 5. EDUCATION AND CULTURE

Article 158. Education and culture shall aim at the development among the citizens of the national spirit, the spirit of self-government, national morality, good physique, scientific knowledge and the ability to earn a living.

Article 159. All citizens shall have equal opportunity to receive an education.

Article 160. All children of school age from 6 to 12 years shall receive free primary education. Those from poor families shall be supplied with books by the Government.

All citizens above school age who have not received primary education shall receive supplementary education free of charge and shall also be supplied with books by the Government.

Article 161. The national, provincial, and local governments shall extensively establish scholarships to assist students of good scholastic standing and exemplary conduct who lack the means to continue their school education.

Article 162. All public and private educational and cultural institutions in the country shall, in accordance with law, be subject to State supervision.

Article 163. The State shall pay due attention to the balanced development of education in different regions, and shall promote social education in order to raise the cultural standard of the citizen in general. Grants from the National Treasury shall be made to frontier regions and economically poor areas to help them meet their educational and cultural expenses. The Central Government may either itself undertake the more important educational and cultural enterprises in such regions or give them financial assistance.

Article 164. Expenditures of educational programs, scientific studies and cultural services shall not be, in respect of the Central Government, less than 15 per cent of the total national budget; in respect of each Province, less than 25 per cent of the total Provincial budgets; and in respect of each Municipality or Hsien, less than 35 per cent of the total Municipal or Hsien budget. Educational and cultural foundations established in accordance with law shall, together with their property, be protected.

Article 165. The State shall safeguard the livelihood of those who work in the fields of education, sciences and arts, and shall, in accordance with the development of national economy, increase their remuneration from time to time.

Article 166. The State shall encourage scientific discoveries and inventions, and shall protect ancient sites and articles of historical, cultural or artistic value.

Article 167. The State shall give encouragement or subsidies to the following enterprises or individuals:

1. Educational enterprises in the country which have been operated with good record by private individuals;
2. Educational enterprises which have been operated with good record by Chinese citizens residing abroad;
3. Persons who have made discoveries or inventions in the fields of learning and technology; and
4. Persons who have rendered long and meritorious services in the field of education.

*<u>China Year Book</u>, 1975, China Publishing Co., Taiwan, pp.637-638

APPENDIX II

Compiled by the staff of the Division of Science Teaching, Unesco, for this volume.

THE UNESCO PILOT PROJECT FOR CHEMISTRY TEACHING IN ASIA

1. BACKGROUND TO THE PILOT PROJECT

The newly-developing nations of Asia are quite aware that their development rests heavily upon their ability to train large numbers of their people to serve as technicians, technologists and scientists. They also are aware that they must spread an understanding of science widely among all their people to form a base for a modern industrial society. Yet their chief instruments for accomplishing these tasks - schools, technical institutes and universities - are seriously weakened by a great shortage of trained science teachers, by a scarcity of modern textbooks, and by inadequate school laboratories and apparatus. They struggle against rigid examination systems and out-dated curricula in their efforts to teach modern science. Far-reaching reform of science teaching is clearly a matter of high priority facing them.

Unesco has not been unresponsive to requests from Asian leaders for help in carrying out this reform. Through Unesco assistance, science instrument repair centres have been built; inexpensive science teaching apparatus has been supplied to schools; advisers on science curriculum reform have been sent to Ministries of Education; teacher-training institutions have been provided expert personnel, fellowships and equipment to increase their ability to prepare science teachers; and Advanced Centres for scientific work have been supplied with scientists of the highest calibre. To coordinate and intensify this assistance, Unesco has established two regional Science Co-operation Offices, one in New Delhi, one in Bangkok.

While continuing these important programmes, Unesco has recognized an urgent need for a new type of assistance to science teaching improvement. In each country in Asia, Unesco finds a small but growing corps of key science educators which is taking on more and more of the responsibility for improving science teaching. These key individuals are writing the new science textbooks needed in the schools; they are organizing and conducting in-service courses for school science teachers; they are modernizing science curricula and syllabuses and overhauling the old examination systems; and they are introducing new techniques of instruction into the schools and universities. These individuals - "the teachers of teachers" - can be found in the science departments of universities and of teacher training colleges and in the science education sections of the ministry of education. But wherever they are working, they are shouldering tasks of enormous magnitude without sufficient assistance to insure the best results of their efforts.

Consequently, Unesco's new type of programme has been focussed upon these key teachers. The strategy is to invest in strengthening their abilities as leaders of science education and to depend upon them to

UNESCO, New Trend In Chemistry Teaching, vol.I,1964-1965, pp.335-346.

reflect this contribution in improvements to all those science teaching activities for which they are responsible. Besides realizing a large multiplying effect in the funds invested (an important consideration in view of Unesco's limited resources), this strategy appears sound in recognising and reinforcing initiative already present among many Asian teachers.

In planning this new programme, Unesco has been guided by several convictions regarding science teaching reform:

(a) The rapid growth of new knowledge in science makes it necessary to carry out the improvement of science teaching as a continuous process;

(b) A vital ingredient in any programme for science teaching improvement must be a dialogue between research scientists and science teachers directed toward clarifying the underlying concepts in each field of science;

(c) Science teachers must be willing to explore the usefulness of the newer techniques for instruction which are being developed by educational research.

2. OBJECTIVES OF THE PILOT PROJECT

The Pilot Project for Chemistry Teaching in Asia, the programme Unesco has established to implement this strategy for science teaching reform, is only a first step, of course, for it is limited for the moment to teachers of chemistry. Nevertheless, it is expected to provide valuable guidelines for future programmes of larger scope involving other sciences and other subjects. The Pilot Project aims to assist the key teachers of chemistry in Asia along two principal lines:

(a) Involving a selected group of them in the creative work of developing new chemistry teaching material at an experimental centre in Asia; this can strengthen their background work in modern chemistry and in the new approaches to teaching and can demonstrate to them how modern chemistry, new teaching techniques, and an integrated set of teaching materials combine to make classroom teaching more effective;

(b) Supplying carefully designed chemistry teaching materials to teachers throughout Asia as resources for the national or local level tasks they are undertaking: writing textbooks for teachers, drafting new syllabuses and examinations, conducting in-service courses for other teachers; etc. These resource materials, based upon recent content in chemistry and upon new techniques of instruction should provide a powerful stimulus to all who are preparing student materials for use in schools and universities.

This programme has been set up as a pilot programme because of the magnitude of the problems to be solved and the vast number of teachers and schools to be assisted in Asia. Only in a pilot project is it likely that reasonably manageable conditions can be assured for conducting the search for solutions to these problems, and only in a pilot project is it likely that ways can be devised to disseminate these solutions effectively to each participating country.

Furthermore, the pilot nature of the project is important in another way: it permits a demonstration to be carried out of the feasibility of involving university and research scientists in the rethinking of school-level science content. All too commonly it is assumed by school authorities and university or research scientists that school science teaching has nothing to gain from university or research scientists. Yet the lessons learned in the recent science, curriculum reform projects of Europe and North America point clearly to a different conclusion: high level scientists, if involved in an appropriate manner in school science reform can make an important contribution to fundamental reform of the content of school science. The challenge facing any project that seeks to be effective is to discover those arrangements by which leading scientists may be usefully involved in reform of school science teaching. The Pilot Project has made a careful attempt to provide just such arrangements in its experimental centre in Asia and Unesco hopes the demonstration proves so convincing that the barriers preventing sincere searches at the national level for cooperation between school authorities and scientists in Asia can be overcome. This cooperation could lead to striking advances in school science reform projects in countries of Asia where scientists of world-reputation are literally waiting to find a way to be useful to their own schools and talented youth. Hopefully, the pilot project will show a way to energize these resources for science teaching improvement while keeping the guidance of schools in the hands of seasoned teachers.

3. THE PLAN OF ORGANIZATION OF THE PILOT PROJECT:

In arriving at the most effective plan for the Pilot Project Unesco has been strongly influenced by the presence in Asia of already existing national projects for science teaching reform + - many with major support from the aid programmes of the higly industrialized nations.

By locating the Pilot Project in Asia, Unesco hopes, for one thing, that benefits to science teaching will arise through a wide

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+ Ceylon, Japan, India, Philippines, Australia, Korea, Taiwan.

interchange of experience among leaders from these Asian curriculum reform projects who are brought together.

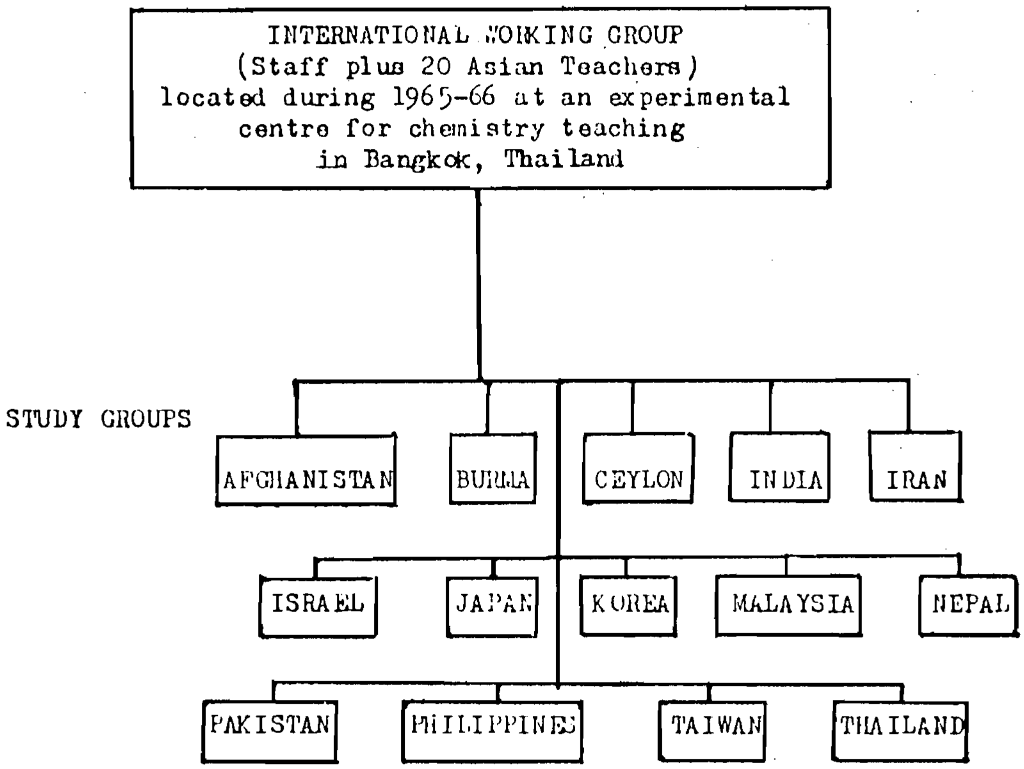
For another, Unesco hopes to involve these national groups in Asia who have begun science curriculum reform in the work of the experimental centre of the Pilot Project. These local groups can supply the Pilot Project a means to field test its materials during their development. In return, the Pilot Project is able to provide resource materials to the national groups for their own tasks.

The organization of the Pilot Project connects an International Working Group, located at an experimental centre for chemistry teaching with national Study Groups in each participating country of Asia. Each Study Group is supplied the resource materials prepared by the International Working Group and, after studying the materials, makes them available to individuals and groups working at the local level on various aspects of chemistry teaching reform. These groups include:

1. Chemistry teachers in universities or teacher training colleges;
2. Science education sections of a Ministry of Education;
3. Curriculum reform committees;
4. Leaders of in-service courses for chemistry teachers;
5. Textbooks-writing teams.

ORGANIZATION OF THE

UNESCO PILOT PROJECT FOR CHEMISTRY TEACHING IN ASIA



The Study Groups are supplied the resource materials in Chemistry Teaching from Bangkok and make them available to national or local units working on curriculum reform.

a. The International Working Group

During 1965-66 a group of twenty chemistry teachers from universities and teacher training institutions of fourteen Asian countries has assembled in Bangkok as the International Working Group of the Unesco Pilot Project. They are devoting a full year to study, laboratory research, and development work on chemistry teaching materials in an experimental centre for chemistry teaching. The experimental centre consists of a well equipped chemical laboratory, audio-visual materials and production facilities, offices and study rooms, and has been made available through co-operation between Unesco and the Government of Thailand. The staff and consultants for the International Working Group are being drawn from among leaders of the chemistry teaching reform projects of Asia, Europe, and the U.S.A. Other consultants include outstanding chemical research scientists and specialists in the new techniques of instruction. (+)

The International Working Group is proving useful as a channel for transfer to Asian teachers of some of the experience on curriculum reform gained in major projects outside of Asia; the Nuffield Chemistry Project in the U.K., and the CHEM Study and Chemical Bond Approach Projects in the U.S.A., for example.

Furthermore, since many of the Asian teachers in the Working Groups have taken leading parts in curriculum reform projects now underway in several of the Asian countries, the International Working Group is proving useful as a means of exchanging these experiences among the Asian teachers themselves.

Since the work at the experimental centre is organized around the preparation of resource materials in chemistry teaching, the programme at the centre includes discussions between consultants and the teachers directed toward clarifying selected topics in chemistry; individual laboratory research in a search for suitable student experiments; preparation of teaching materials based upon new techniques of learning; 8mm, film loops, programmed learning, etc.

Unesco believes that the contribution which this work in the experimental centre is making to these selected teachers is two-fold: it is providing them, as stated earlier in the aims of the project, an opportunity to strengthen their own backgrounds in modern chemistry and in an understanding of the new approaches and techniques for teaching chemistry; but it is also opening their eyes to the fact that participation in curriculum reform is now becoming widely recognized as an expected responsibility of all science teachers. It is to be thought of as normal mode of his professional life as a teacher.

b. Study Groups

Unesco has invited each participating country to organize one or more national Study Groups. A typical Study Group in a country contains university chemistry teachers, secondary school chemistry teachers, science education specialists from ministries of education, and often times a research chemist. In most cases the participation is voluntary, though in some countries a more formal arrangement has been worked out regarding membership in the Group.

The Study Groups meet at regular intervals to examine and comment critically upon the resource materials sent from the International Working Group of the Pilot Project. Unesco is also sending these Study Groups textbooks, teachers guides, laboratory manuals, films, and other teaching materials from some of the more important chemistry reform projects in the world, and as a consequence, Study Groups are able to function in each country as clearinghouses of chemistry teaching materials, a function of considerable value to teachers in schools and universities who desire access to such information.

The most important function of the Study Groups is their work in linking the International Working Group of the Pilot Project with individual or group effort in each country directed toward writing new textbooks, conducting in-service courses for chemistry teachers, or carrying on curriculum reforms. The Study Groups are bringing to the attention of these efforts the Unesco resource materials and in many cases, suggesting possible use of the materials at local levels. The Study Groups have been instructed, of course, to respect the rights of all who accept the Unesco resource materials to use them on their own terms.

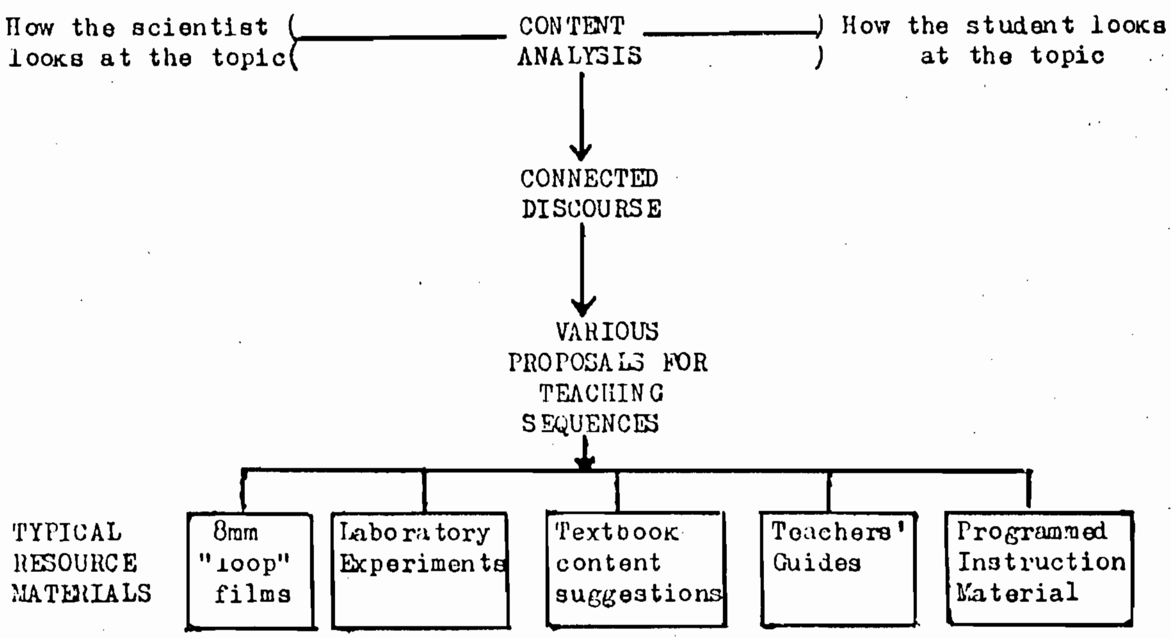
4. PREPARATION OF THE RESOURCE MATERIALS

The strategy which guides the International Working Group in preparing resource materials embraces two central propositions whose validity for science teaching reform has been suggested by work in some of the major projects mentioned earlier:

The first of those propositions raises the possibility that many attempts to improve chemistry teaching are frustrated by insufficient attention to the nature of chemistry itself. The basic question is: What could be accomplished through a careful examination by competent chemists and experienced teachers of the principles and practice that comprise chemistry? The Pilot Project asks the teachers to take this question seriously and has arranged for them to devote considerable time to a careful examination of selected areas of chemistry content. This examination, referred to as content analysis, has already indicated a variety of gaps and ambiguities in conventional presentations of chemistry.

The second of those propositions stems from preliminary experiments with new techniques of instruction. These experiments raise the possibility that a teacher's outreach and effectiveness might be considerably increased through the new techniques, e.g. 8mm film loops, programmed learning, inexpensive laboratory kits, etc. Even more important, the experiments suggest that these techniques may encourage students to shoulder more of the responsibility for their own learning of science. These possibilities are being examined by the Pilot Project. Sets of carefully integrated media for instruction prepared on the basis of analysis of each topic are being supplied to the Study Groups in each country in the hope that they will stimulate further work along the lines opened up by the International Working Group. Only a limited amount of testing of these materials with Asian school children can be attempted in the Project. Extensive adaptation and testing in actual school situations must be assumed by local groups under supervision of experts in science education

A diagrammatic presentation of the procedures followed by the International Working Group



A. <u>Content Analysis</u>

During 1965-66, three topics recognized as connecting threads in much of the chemistry taught in schools have been selected for work in the Centre by a panel of scientific advisors to the Pilot Project: (+)

Mass relationships among reacting substances;
Energy in chemical reactions;
The rôle of structure in chemistry.

(+) Report of Moscow Planning Meeting of Unesco Pilot Project, September 1964.

The analysis of each of these topics begins with questioning the adequacy of definitions of terms commonly used in textbooks. A search for "operational" ways to relate these terms with student experience leads the participants to a considerable amount of laboratory research on suitable experiments for student use. Finally, an effort is made to link each topic to other parts of chemistry. A fuller account of those procedures, as well as suggestions of additional topics likely to occupy the participants in such a Centre in subsequent years, appear in a paper by the Project Director, entitled: <u>Content Analysis as a Major Strategy for Curriculum Reform.</u>

The crucially important feature of successful content analysis is that the particular chemical topic under examination must be kept subject to two points of view:

1. The point of view of the scientist who insists upon reliability of evidence, experimental support of ideas, and a contemporary understanding of the topic;

2. The point of view of the student in the classroom who is attempting to understand the topic as a part of the subject of chemistry he is studying.

A balance between these two points of view is essential to any successful reformulation of a topic in chemistry. The Pilot Project participants are devoting considerable effort to attaining this balance by finding ways to overcome the usual barriers to effective dialogue between those who look on chemistry primarily as scientists and those who are concerned primarily with the way a student understands chemistry. There is little doubt that one of the most important recommendations for curriculum reform arising from this Pilot Project is that this dialogue between teachers and scientists should go on continuously within an appropriate centre to provide a constant supply of fresh thinking on what is taught in the science courses in the schools.

D. <u>Connected Discourse</u>

The content analysis of each topic in chemistry is finally summarized in the form of a <u>connected discourse</u>, often in the form of a monograph. The question then arises, "What is the best way to distribute this content over the teaching techniques available - films, texts, programmed learning material, laboratory experiments, etc." The present view in the Project is that no really reliable theory exists with which to answer this question. Instead, the experience of individual members of the project is suggesting different empirical approaches which will be compared eventually in terms of their effectiveness in aiding student understanding. This step is referred to as the preparation of <u>teaching sequences</u>.

C. Preparation of resource materials

One of the best ways to assist the teachers in the Pilot Project to become acquainted with modern principles of learning theory and with new techniques of instruction is to ask them to develop carefully integrated sets of teaching materials based upon these principles and techniques. Unesco has brought to the centre highly experienced consultants on such topics as audio-visual techniques and programmed instruction. The resource materials produced are to be labelled as "experimental and tentative" because more exhaustive testing of these sets under conditions of actual schoolroom use will be required to determine their validity in schools. Since in almost all countries the testing of experimental teaching materials with children in school is a prerogative of education ministries and teacher training colleges, the Unesco policy is to restrict the Pilot Project work to preparation of these sets of materials as resources for local experimentation.

D. The Search for meaningful laboratory experiments

The chemical laboratory is a central feature of the experimental centre. The Pilot Project staff and participants are devoting considerable effort to laboratory work in which a search is underway for meaningful experiments for students. The criteria for such student laboratory experiments are stringent ones:

1. The experiment should have a clear scientific purpose. While exercises to teach the use of equipment, and to demonstrate difficult principles are occasionally useful, a better experiment will provide data that answers a specific question. The best experiment provides data that answers a question at the same time that it raises new questions. In all cases, the purpose of the search must be clearly understood by the student so that the data-gathering techniques appear relevant to him.

2. The experimental techniques and apparatus must be appropriate. If the laboratory is a place for gathering ideas, then complicated equipment and difficult techniques can only get in the way. The very real problem of lack of equipment in Asian schools confronts the Pilot Project with the task of searching for simple procedures using the most readily available chemicals and the most familiar types of apparatus.

3. The experiment should be honest according to the best available knowledge of the underlying chemistry. Often, by selecting specific reactions or specific conditions, one can use a false experiment to gather good data. However, the end does not justify the means. Chemical problems should be faced squarely, and the spurious experiment discarded, or else put in a context where its falseness is brought to light.

4. The experiment should be reproducible by the class of students who use it. Careless work should never be encouraged: measurements should be made to the limit of convenient accuracy, unless it is knowingly done to gain an order of magnitude estimate. Such matters as errors in measurement, significant figures and reproducibility are a necessary part of the laboratory procedure.

5. The experiment should encourage genuine independent inquiry. The pursuit of chemical fact and theory is a never-ending quest. In such experiments, even the unimaginative student can be made to see the need for and be inspired to do unscheduled but supervised work.

The Application of 'Thought Pattern' to CHEMS Experiment

CHEM Study Experiment 3

Density of two metals

A) Comprehending Knowledge

I) Observing:

a) the weight in grams of two different metals,

b) the measurement of the volume of two different metals by means of a ruler or by water displacement.

2) Comparing:

a) the mass-volume relationship for one metal to the mass-volume relationship for a different metal,

b) the densities of the given metals to the densities of materials listed in the Handbook of Chemistry and Physics,

c) the two methods for volume determination;

1) length, width and height measurement using a ruler,

2) water displacement.

3) Classifying: in tabular form the respective mass and volume data corresponding to the two different metals.

Metal 1		Metal 2	
Mass (g)	Volume (ml)	Mass (g)	Volume (ml)
34.0	4.7	8.0	4.4
37.0	5.3	14.0	4.5
37.0	5.3	15.0	4.5
47.0	5.9	16.0	5.0
49.0	6.4	18.0	6.7
57.0	6.7	18.5	7.0
58.0	7.0	20.0	8.0
67.1	8.9	22.0	8.9

4) Interpreting:

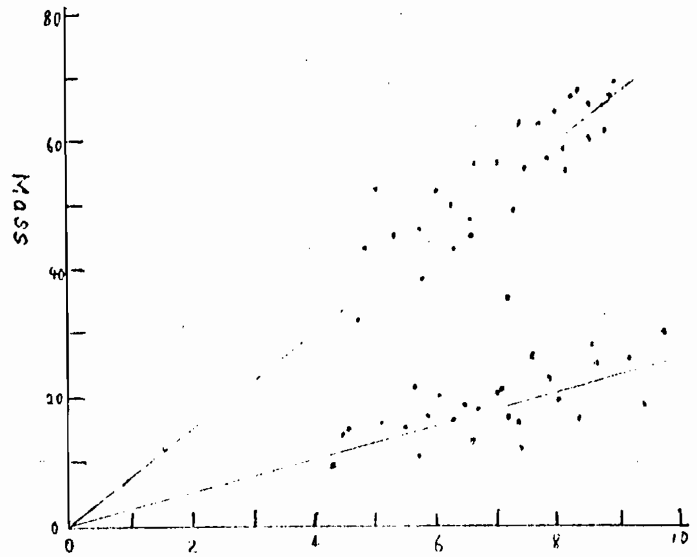
a) it is probable that the two metals have a different composition,

b) it is probable that the distance of a point from the mean, the solid line of the graph is caused by the three types of error:

1) error due to the method,

2) error due to the experimenter,

3) systematic error.



B) In the Application of Knowledge:

1) Rearranging: the class mass and volume data in order of increasing value.

2) Relating: the slopes of the solid graph lines to the most probable density of the respective metals.

3) Explaining: the ratio of mass to volume of a given substance is equivalent to its density.

4) Predicting: A substance will usually show the same value for the mass-volume relationship.

5) Estimating:

a) the most probable densities of the two metals:

1) 7.64 g/ml., 2) 2.85 g/ml.,

b) the possible errors due to the two methods of volume measurement:

1) uncertainty in length reading: 0.2mm. (ruler),

2) uncertainty in cylinder reading: 0.2ml.

C) In the Evaluation of Knowledge:

1) Justifying: The respective densities of the two metals are determined a number of times because the mean of the values (solid graph line) represents "reality" better than a single value.

2) Assuming:

a) that the composition of:

1) metal one is the same throughout,

2) metal two is the same throughout,

b) all the class is using the same two metals.

3) Discovering: the fact that there is a contant relationship between the mass and volume for a specific substance.

4) Hypothesising:

a) different metals will show different constant values for the mass-volume relationship.

b) metals can be identified by estimating their densities and then comparing them to the densities listed in a previously prepared chart.

5) Testing and Reassessing the Hypothesis: experiments were performed in order to determine the densities of other metals.* These densities were then compared to constants given in the Handbook of Chemistry and Physics. Identification of the metals was thus achieved.

* Introductry Physical Science, A Useful Background for CHEM. Study Students, Angela D'Amboise, McGill University, Montreal, 1972. pp.26-33.

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