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Soviet Education Programs

- **FOUNDATIONS**
- **CURRICULUMS**
- **TEACHER PREPARATION**

WILLIAM K. MEDLIN, *Specialist in Comparative Education for Eastern Europe, Division of International Education*

CLARENCE B. LINDQUIST, *Chief for Natural Sciences and Mathematics, Division of Higher Education*

MARSHALL L. SCHMITT, *Specialist for Industrial Arts, Division of State and Local School Systems*

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
ARTHUR S. FLEMMING, *Secretary*

Office of Education
LAWRENCE G. DERTHICK, *Commissioner*

Foreword

THE CONTINUING INTEREST which American educators and other citizens have attached to Soviet schools and their development has served to encourage the U.S. Office of Education in its efforts to provide the most complete and verified information obtainable on the subject. As expressed in our *Soviet Commitment to Education, Report of the First Official U.S. Education Mission to the U.S.S.R.* "We are convinced that it is important for the American people to examine the Soviet program closely and to keep up-to-date on the developments and trends in Soviet education."

In pursuit of these aims, the Office of Education sent a second official group of specialists to the U.S.S.R. in the spring of 1959 with the specific objectives of looking carefully at the teaching methods, the general facilities, and the student performances in areas of education particularly emphasized by Soviet authorities in the general school system. At the same time, it was deemed important to study both the foundations and the balance between science and nonscience subjects in the curriculums of Soviet education. The three specialists—William K. Medlin, Clarence B. Lindquist, and Marshall L. Schmitt—under the guidance of Dr. Medlin, the Division of International Education's Specialist in Comparative Education for Eastern Europe, spent a month (May 9 to June 6, 1959) in the U.S.S.R. for these purposes. The present report is the result of their findings.

This Bulletin is the third major study in as many years prepared and published by the Office of Education on education in the Soviet Union. It was preceded by *Education in the U.S.S.R.* (Bulletin 1957, No. 14) and by *Soviet Commitment to Education* (Bulletin 1959, No. 16), released in September 1959. Both of these publications cover extensively the programs of education which have been in effect in the Republics of the Soviet Union in recent years. The current publication deals specifically with the foundations, science and polytechnic curriculums in the general school, and with teacher preparation.

It is our hope and belief that the authors' findings in such areas will prove especially useful to organizations and individuals seeking factual and documented information concerning *Soviet Education Programs.*

Lawrence G. Derthick

Commissioner of Education

Acknowledgments

THE OFFICE OF EDUCATION expresses its sincere appreciation to all individuals and institutions in the U.S.S.R. that in various ways contributed helpful information and services toward making this bulletin possible.

The authors have expressed particular appreciation of the helpfulness given them by leading educational workers in the Russian, Ukrainian, and Georgian Ministries of Education, and by workers in their city and rural schools. Directors of pedagogical institutes, and directors of schools, professors, other teachers and students, educational researchers, and many other individuals also were among those whose cooperation was of great value to the Office of Education research team visiting in the Soviet Union during the spring of 1959. These visits resulted in the development of this bulletin reporting on *Soviet Education Programs.*

OLIVER J. CALDWELL,
Assistant Commissioner for International Education

BESS GOODYKOONTZ, *Director International Educational Relations*

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Introduction

AS THE SECOND GROUP of educators sent by the U.S. Office of Education to the U.S.S.R. under the Soviet-American cultural exchange agreement, we were prepared to study specific aspects of education in that country. From the experiences of those who had gone before us, we had understood and anticipated that these aspects were particularly emphasized by Soviet educational authorities: the basic formation in mathematics, natural sciences, and polytechnic knowledge related to economic production. Since most educational systems and their curriculums are shaped by fundamental concepts and policies, we were naturally interested in those features which are termed the foundations of Soviet and Russian education. Similarly, it proved useful in our study to examine the general principles and methodological framework according to which Soviet teachers work and through which some of the special practices in Soviet education can be interpreted. We also went to Russia aware of the major reform movement underway in education there, and with the intention of seeing as closely as possible the features of the reform and their implementation in those schools which were in a state of transition.

From the moment we stepped into the Soviet jet TU-104 in Copenhagen, which would wing us seemingly without effort to Moscow within 3 hours, we sensed the technological push that later would be evidenced to us in the educational work going on in the Soviet Union. As we flew over the northern flank of the broad East European shelf and into the heart of Russia, we were able to glimpse some of the vastness (over 8 million square miles) of the land whose schools were to be our host. At the same time, we tried to disabuse ourselves from a concern with the geographical extent of this visit, taking comfort in the fact that the nine educators and Commissioner of Education Derthick in 1958 had accomplished a great deal in that direction and had come back with a keen awareness of the great commitment of Soviet peoples to education. We knew too that the vastness of the Soviet Union was knit together educationally by a unified system of general education administered

through central political controls. With these notions in mind, we decided to concentrate our school visit in the Western regions of the U.S.S.R. Authorities in the Ministry of Education of the Russian Soviet Federated Socialist Republic at Moscow, which was our official host, kindly agreed to arrange for us visits not only in Russia proper but also in Ukraine (south of Russia) and in Georgia (in the Caucasus), which are 2 of the other 14 Soviet Republics comprising the U.S.S.R. (See p. XVI for a list of places and schools visited.)

In the school classroom and workshop, in the machine building plant, in the countryside, and wherever we went, we felt the pulse of the Soviet Government's drive to educate and train a new generation of technically skilled and scientifically literate citizens. In the field of general and teacher education, we tried to examine as closely as possible the foundational aspects of their school enterprises, as well as the work of their teachers and students in the areas of mathematics, science, and polytechnic courses. While our efforts were limited to a month's visit, we saw elementary-secondary schools and teachers colleges of various sizes located in different cultural regions. We attempted to limit the number of visits and the distances travelled in order to concentrate on certain programs of study and on certain schools. We spent 2 to 3 days in some institutions for this purpose. By this approach we accomplished a considerable amount and feel that in the main we achieved our mission.

Even so, our visits cannot be judged as fully representative or complete for the educational sectors we sought to study. Schools vary significantly in composition and quality in most countries, and the U.S.S.R. is no exception. We saw some of its best schools and some of its average ones. Naturally, we have attempted to make effective use of official Soviet materials on educational programs and to verify through our visits the teaching described therein. We lay before the reader our findings, hoping that they may prove to be worth the efforts expended. This study is essentially a descriptive one within the framework of comparative education. It is not, however, by virtue of this relationship a *comparative* study or interpretation. We direct the reader to Chapter V, "Conclusions," for our final statement on the matter.

The conception and purpose of our mission were not only educational and technical, but also partly cultural. Under the exchange agreement on cultural relations between the Governments of the United States and the Soviet Union, signed on January 27, 1958, and renewed on November 21, 1959, educators from both

countries are exploring the ways of living and thinking in each other's country. For us, travelling and observing in the U.S.S.R. were thrilling cultural experiences. Our hosts in Moscow, Kiev, Tbilisi, Leningrad, and outlying points were most attentive to our interests and helped us take note of long-established traditions and ancient monuments that mark the way their peoples have trod across the centuries. They took us to musical concerts, theatrical performances, and art exhibits that testified to their many accomplishments in these fields. We left their country with many new impressions and with some added assurances about the usefulness of cultural exchange.

In the pages that follow, a certain division of labor was followed throughout. Writing and research of the first and fifth chapters were the primary responsibility of William K. Medlin; the second and fourth chapters, of Clarence B. Lindquist; and chapter three, Marshall L. Schmitt. All three authors collaborated in providing the documentary materials in the appendixes, in advising each other on their respective tasks, and in supplying basic interpretations for the chapter on conclusions.

Schools and Institutes Visited

I. 7-year, 10-year, and 11-year Schools

Name	*Type*	*Location*	*Enrollment*
Number 204	11-year	Moscow	1,050
Lenin School (rural)	11-year	Gorki-Leninskie	650
Number 12	Boarding	Moscow	300
" 14	10-year	Zagorsk	1,500
" 20	7-year	Zagorsk district	340
" 16	11-year	Moscow	1,037
" 57	10-year	Kiev	880
" 112	10-year	Kiev	657
" 6	10-year	Kiev	723
" 43	10-year	Kiev	1,150
" 44	10-year	Kiev	1,200
Sagaredzho (rural)	10-year	Georgian S.S.R.	916
Number 5	Vocational-Technical[1]	Tbilisi	—
" 4	11-year	Leningrad	1,025

[1] A 4-year program based on 7 years of general education.

II. Teacher-Training Institutions

Name	Location	Total enrollment (day, evening, and correspondence)
Krupskaia Pedagogical Institute	Moscow	7,500
Lenin Pedagogical Institute	Moscow	4,000
Pedagogical School Number 2	Moscow	530
Gor'kii Pedagogical Institute	Kiev	3,050
Pushkin Pedagogical Institute	Tbilisi	5,708
Hertsen Pedagogical Institute	Leningrad	16,500

III. Inservice Institutes for Teachers

Name	Location	Total enrollment
Inservice Training Institute	Leningrad	3,500
Inservice Training Institute	Moscow	6,000[2]

[2] Total annual registrations. Regular enrollments in weekly courses are 2,500.

IV. Pedagogical Research Institutes

Name	Location
Methods of Teaching	Moscow
Theory and History of Education	Moscow
Defectology	Moscow
Psychology	Moscow
Psychology	Kiev
Pedagogy	Leningrad

Collaboration in research, interpretation, and technical preparation of documentary materials was provided by Nicholas J. Rokitiansky of the Division of International Education.

CHAPTER 1

Foundations of Soviet Educational Practices

THE PRESENT SYSTEMS of schools and educational methods in the U.S.S.R. are outcomes of many and complex factors and developments—historical, economic, social, psychological and cultural—as well as educational theories derived from these areas and scientific investigations into education. In order to help us understand the school programs and how they function, this chapter will briefly analyze those factors in their relationships to current educational practices, and will consider the status of Soviet education today.

In Russia, public school systems are, historically speaking, a recent phenomenon, and popular instruction in knowledge about the world developed later than in most other societies in Western civilization. During the 18th century, the first secular schools were small and, for the most part, socially exclusive. Only in the latter half of the 19th century did the Russians succeed in establishing some basis for the expansive developments we are witnessing in the 20th century. Early efforts were small and usually came from the initiative of the crown.

During the last decades of the 1800's and especially the years prior to the 1917 Revolution, popular movements for education brought steady increases in school facilities. These late beginnings were primarily responsible for the relatively narrow national bases on which Soviet educators began to build a public schools system in the 1920's and 1930's. Particularly since 1930, therefore, a rather phenomenal growth has occurred in educational facilities in the U.S.S.R., moving steadily in the direction of universal, compulsory general education. In recent years, this movement has tended toward the goal of universal high school education, but had not reached that point when major reforms were enacted into law late in 1958. During this period of rapid

growth, curriculum and methods have responded primarily to economic requirements of society.

Historical Problems

ECONOMIC DEVELOPMENT

Historical problems of Russian education can be written largely in terms of economic and social conditions. Until late in the 19th century, the material exploitation of Russia had progressed slowly. Linked closely to this situation was the main social problem of serfdom, which was legally abolished during the 1860's. The availability thereafter of skilled manpower for economic growth became primarily a function of school facilities.

In other major European countries and in America, industrial growth and applied science had advanced, during the last half of the 19th century, at a much greater pace than in Russia. As the urgencies, after 1900, for the material exploitation of the country and for securing its international position pressed against the capacities of the people, it became evident that educational facilities would have to be developed at great speed in the decades ahead. Since 60 percent of the adult male population were illiterate in 1900, a massive educational effort was deemed necessary to transform this situation into one where new skills and scientific inquiry could meet national needs. The rate of Russian industrial growth progressed rapidly after 1900 and, during the Soviet period, was set at ambitious paces through the 5-year plans beginning in 1928, which is a chronological demarcation point in Soviet society. Because of the country's recent economic development and since Soviet authorities have established priorities sharply favoring heavy industrial production, educational programs have been designed to meet those fundamental needs. The proportion of total planned investment in the national economy going into heavy industry has been and is to continue to be 70 percent in the new 7-year plan (1959–1965).

The proportions of the adult population employed in various sectors of the economy are similarly indicative of industrial emphasis. As of 1956, according to Soviet statistics, 85.2 percent of the adult population were employed in productive branches of industry and agriculture; only 14.8 percent were working in administrative, distributive, and welfare services, including educa-

tion.[1] These factors have definite effects on education, on the preparation for life that youth must receive in school. In conjunction with economic plans, the planning for and control over school programs are devised by central authorities and administered by national, republic, and local organs of government functioning along a decentralized pattern.[2] The main tasks of U.S.S.R. schools over the past 30 years have therefore been to train youngsters for the government's planned economic programs and to inculcate devotion to its political and social system.

SOCIAL DEVELOPMENT

The Russian Empire entered the 20th century with a highly stratified social structure that was undergoing strains and great pressures for change, and changes were in fact rapidly taking place in Russian society. At the top of the social pyramid were the Emperor (Tsar), his family, and related imperial and princely families. A landed and titled nobility with extensive privileges ranked next, followed by a sizable class of officials whose upper ranks enjoyed prestige conferred by their positions and economic status. Entrepreneurs and men of commerce were not numerous, but they were important in the social and cultural, as well as economic, life of the towns. The Russian clergy composed another distinct social group having its own somewhat corporate character. Taken together, these social groups accounted in 1900 for about 3 percent of the total population. In terms of educational opportunity, their children constituted about 40 percent of the total enrollment in secondary schools of the Ministry of Public Instruction.[3] In institutions of higher learning, 61 percent of the students in 1914 came from these social groups.

Persons employed in agriculture, including small holders, and in industrial enterprises together accounted for approximately 87 percent of the total population. Their children made up 57 percent and 39 percent of the enrollments in fee-requiring secondary schools and higher institutions, respectively. The late emergence (after 1860) of Russian masses from the conditions of serfdom

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[1] S. G. Shapovalenko, *ed. Soedinenie obucheniia s proizvoditel'nym trudom uchashchikhsia.* (Combining instruction with production work of pupils.) Moscow, R.S.F.S.R. Academy of Pedagogical Sciences, 1958. P. 7.

[2] *Soviet Commitment to Education.* U.S. Department of Health, Education, and Welfare, Office of Education. (Bulletin 1959 No. 16.) Washington, U.S. Government Printing Office, 1959. P. 8.

[3] Total enrollments (1914) in these schools were 556,487, but there were 135,769 pupils in other secondary schools, the majority of whom came from the social groups mentioned. Cf. Nicholas Hans, *History of Russian Educational Policy.* pp. 235–39: also, *Ezhegodnik Rossii* (Yearbook of Russia), 1906, St. Petersburg, *Tsentral'nyi Statisticheskii Komitet, 1907.*

made the rapid development of educational facilities both burdensome and urgent. This slow appearance of a free labor supply was closely related to Russia's tardy industrialization and social development, which in turn were hampered by the lack of a broadly based school system.

GEOGRAPHY

Bearing on the U.S.S.R.'s historical problems of economic and social development has been her geographical position. Steadily expanding from her European homeland after the 15th century, Russia came to occupy by the 20th century the vast Eurasian plain and plateau which, with little interruption, stretch eastward for thousands of miles to the Great Mongolian Plateau and, eventually, to the Pacific Ocean. These plain-plateau regions have served for over a thousand years as avenues for great human migrations and for building empires.

One major outcome of this situation is that the changing ethnic tides have left both islands of various cultures and mixed ethnic and cultural features that today give Soviet schools their particular imprints. Another result is that this immense region, until recently very sparsely populated and little developed in the central and eastern parts, has presented and continues to present a large problem for the manpower and resources development capacity of the nation.

The kinds of education, training, and related experiences which Soviet youth receive are closely related to these problems emerging from geography. They are factors, therefore, which should enter into any consideration of education in the Soviet Union. Our mention of them here merely points to their seeming importance and complexity.

SCHOOL SYSTEM

Years of war and revolution (1914–1921) delayed and disrupted building a national school system until the 1920's. These delays, followed by new economic priorities, had the effect of limiting education of the masses to the rudiments of literacy and elementary education. A systematic reestablishment of school systems came after 1928, when the Soviet Government launched the first in its series of priority economic plans. A minimum general education of 4 and then of 7 years was provided for all and, for those who qualified, desired to continue, and were admitted, a unified secondary school leading to the university or to specialized vocations was provided. During the period from

1935 to 1955, universal public education became a policy of the Government which made free and compulsory 7-year schooling available to the overwhelming majority of Soviet children whose grandparents, and many of their parents, had been either illiterates or the recipients of an elementary education only. By the 1955–56 school year, over 5 million youngsters were enrolled in academic high schools, and another 2½ million, in vocational, technical, and specialized schools beyond the 7th grade. The sociological aspects of this "educational revolution" in a little more than one generation invite attention, but are not the subject of this study.

Russian school systems prior to 1917 were, in general, similar to those which then characterized various European school systems. Three or four years of primary school were followed by enrollment in one of several different kinds of schools, independent of and parallel to each other: academic (college preparatory), vocational, technical, commercial, and so forth. Transfers into one of these or other specialized schools (*e.g.*, pedagogical or medical) might also occur at a later point in a pupil's general school program. The main feature of this parallel system, however, was its rigid socioeconomic framework.

The curriculum in the academic school was a "classical" or traditional type (emphasizing either the classics or modern subjects) and required the pupils to master much subject matter preparatory to studying for the professions (law, letters, medicine-dentistry, or technology) at the university. Under these organizational and curricular patterns, access to the liberal professions, intellectual enlightenment, and technical careers was limited to small proportions of the total young population.

After the establishment of the Soviet State, these patterns changed little in form but substantially in content, involving new selection criteria for advancement to secondary and higher education, and new subject matter as well as didactics. Particularly during the curriculum reforms of the 1930's did the traditional academic structure reaffirm itself in Russian education after a decade of experimentation. Absent were Greek, Latin, and religion as subjects, being replaced by modern languages, sciences, and political instruction. These general characteristics of the Soviet school system endured almost intact up to the 1958–59 school year, when new laws and large-scale experimentation began to work radical changes in Soviet educational practices.

One other characteristic of Russian education, not unrelated to recent policy developments, has been a historical concern for

manual, technical, and labor training in the schools. Already in the 1860's and 1870's some Russian educators saw the need for combining theoretical instruction with manual and practical work experiences. Some legislation and experiments led to curriculum changes in this respect, but these ideas did not become widespread in the schools of general education. Nonetheless, a certain tradition had been established, and we note that in the 1890's Russian educators advocated instruction in agriculture and in industrial work, which not only would help young people in the "real" world but also would inculcate (especially on children of the upper classes) respect for work and a sense of beauty in the realm of physical forms.[4]

POLITICAL SYSTEM

The vast regions of the Russian Empire (now the Soviet Union) were ruled for centuries by highly centralized institutions of Government. In the development of educational policies and institutions as well as in other activities of society, central authorities have exercised decisive influences. After a few months of a provisional government in 1917, a new form of centralized authority replaced the old imperial organs of government. Under firm Communist Party direction, the new Soviet Government continued a system of extremely centralized political controls. This system is officially termed by Soviet authorities a dictatorship of the proletariat.

Applying itself to education, this system exerts overall policy direction of educational developments and carefully worked-out measures of inspection and fiscal controls. Soviet education is administered, therefore, according to centralized ministerial principles traditionally practiced in many countries.

The several problems briefly touched upon here are the major ones which over many decades have been instrumental in shaping Russian schools, and which continue to exercise strong influences at the present juncture in the history of education in the U.S.S.R.

PHILOSOPHY AND CONCEPTS OF EDUCATION

The prevailing and official philosophy in Soviet intellectual, academic, and scientific work is dialectical and historical materialism (popularly called "Marxism-Leninism"). This philosophy teaches that matter, in its various solid, liquid, energy, or

[4] See, *Report of the Commissioner of Education for the Year 1890–91*, Vol. 1 "Education in Russia," by Frances G. French. Washington, U.S. Government Printing Office, 1893. Pp. 242–261.

ethereal forms, is an absolute and eternal quantity. Based essentially on concepts of 19th-century physics, it permeates the basic courses in all curriculums to inculcate on students a "scientific-atheistic" understanding of the world.

According to Marxism-Leninism, society has historically developed and still develops in line with fundamental economic laws only, to which all other institutions, including education, are ancillary. These ancillary institutions are termed "superstructure." Schools are seen merely to reflect economic relations of society, in which pluralistic concepts are to have no place. Soviet philosophy admits that theory and practice interact and are modified. As Soviet economic and political programs have become ever more deterministic in all phases of life, these principles have in effect been oriented so as to construct a philosophy of education which appears to have pragmatic and perhaps expedient characteristics. These characteristics can be seen in the Government's recent decision to carry out extensive reforms in Soviet education.

Soviet philosophy envisages an ideal socioeconomic order (communism) for mankind and so endows itself with an *idealistic* nature. One must reckon with this idealism in examining the characteristics of Soviet society and its schools. The history of Russian philosophy before the Soviet period is marked by strong currents of idealism. This tradition appears not to have been lost in contemporary applications of dialectical and historical materialism, which at the same time provides a new frame of reference for social action in the field of education.

While materialism is the official philosophy, there appear to be other ideas which animate both intellectual life and educational philosophy, and which are at pains to find a source in the doctrine of dialectical and historical materialism. One of these is the overwhelming conviction, which one finds in Soviet educators and parents, that the primary path to a better future is through education, through intellectual improvement. This conviction motivates a great inner drive to master knowledge and its applications, an intellectual thirst that is prepared to endure other deprivations to satisfy itself. The U.S.S.R. Minister of Higher and Secondary Special Education recently expressed this faith to us in his own way when he said: "We in the Soviet Union believe absolutely in the victory of science; we believe that science leads to truth. We have everything to gain by giving our youth the best education possible." Other Soviet educators and teachers have expressed similar views. Such conviction is an article of

faith which draws its strength from deep motivation. Without it, Soviet school plans might be something different today.

"Free and universal public education" is another foundation of the Soviet system of education. Prior to legislation on the current reforms, the U.S.S.R. Constitution (article 121) stated: "Citizens of the U.S.S.R. have the right to education. This right is ensured by universal compulsory seven-year education; by extensive development of ten-year education, by free education in all schools . . . by a system of state grants for students of higher schools who excel in their studies; by instruction in schools being conducted in the native language. . . ." This provision has been amended to read 8-year and 11-year education, and to give education a polytechnic orientation. All schools except the military are coeducational.

Many of these various ideas about education and its philosophy are not peculiar to the Soviet period of Russian history only. They have their earlier traditions in the fabric of Russian culture out of which Soviet society has emerged over the past 41 years. Furthermore, loyalty to the homeland and to the authorities invested with the power to defend it is a longstanding national characteristic that continues to be a great significant force in today's Russia. The schools imbide and teach such traditions. Lenin himself, referring to cultural legacies of the past, acknowledged the worth of certain achievements made in imperial times: "We can build communism only on the stock of knowledge, organizations, institutions . . . human forces and means left to us from the old society," and "we must take what was useful" from the old school.[5]

Because of a return during the 1930's and 1940's to some principles of education practiced before the 1917 Revolution, Soviet educators have endowed their philosophy with a certain traditional or "essential" character. These principles include curriculum construction with a main emphasis on pupils' acquiring a definite amount of subject matter in all disciplines; the selective procedures for student promotions, based primarily on rigid, subject-centered examinations; and the organization of schools in different parallel systems. They have introduced the prerevolutionary concept of medal winners: "gold medal" and "silver medal" recipients. These students are the ones who have received all "A" grades or mostly "A" with some "B" grades, and these honors earn them preferential treatment in higher education.

[5] V. I. Lenin. *Sochinenia.* (Works.) 4th ed., vol. 31. Moscow, Gospolitizdat, 1950. Pp. 259-261.

These principles of selection reflect a philosophy of education that views secondary and higher education as not the province of all those who want to obtain academic and professional preparation, but rather of those who qualify according to the selective criteria. The tendency of such a system is, of course, to make the upper grades and university years exclusive. As we shall observe later in this study, however, these principles are now undergoing transformation.

Important for Soviet educational thought has been the life work of Anton S. Makarenko, a Soviet Ukrainian pedagog who during the 1920's and 1930's developed a theory and system of education by working with derelict youth. Often working in opposition to officially announced educational principles and policies, Makarenko drew an important body of educational rules, methods, and moral principles directly from experiences in the school. Although these ideas were by-and-large not founded explicitly in teachings of Marx and Lenin, their "main object . . . was to demonstrate how collective discipline may be established and maintained," a goal which at length found support in the governing councils of the Soviet Union.[6] Today, Makarenko's work retains a high place in the thinking and practice of Soviet educators.

It is also instructive to examine the psychological foundations of Soviet education and their implications for a philosophy of education. Most psychological research in the U.S.S.R. concerns problems in the educational field. Like philosophy, Soviet psychology is founded on the materialistic, monistic concept of the world which recognizes only nature (or matter) as the source of mind and consciousness. The entire mental activity of man is seen as a reflection by his nervous system of the real world (the physical world) and of his relationships to this world. Man's spiritual development is held to consist of the development of the qualities of the personality, especially of its talents and abilities. Through instruction and a controlled environment, man conditions himself to using his qualities in the common social interest.

According to Soviet educational theory, children are fashioned by environment, by mentally absorbing their environment and then transforming these ideas into personal experiences. Environment includes almost everything in experience. These experiences are to be self-disciplining, conscious ones wherein the individual

[6] Frederic Lilge. *Anton Semyonovitch Makarenko.* An analysis of his educational ideas in the context of Soviet society. University of California Publications in Education, vol. 13, No. 1. Berkeley and Los Angeles, University of California Press, 1958. Pp. 37–38.

Figure 1-1.—Returning from physical exercise, rural school, Moscow Oblast.

contributes his utmost to society while living in harmony, or in agreement, with it. Soviet patriotism—fidelity to the Soviet land and to the ideas of communism—occupies a leading place in this educational conditioning, and in this sense it gives the school a political character as well as a moral one.

Employing primarily the conditioned reflex theory as elaborated by Pavlov (1849–1936), Soviet psychologists have worked out a system of didactics which are strict and fixed in their conception and application; one might even use the term "narrow" to distinguish them from the broad scope of methods employed, for example, in most U.S. schools. Soviet psychologists maintain that fundamentally all (except physically disturbed or handicapped) children can learn the standardized subject matter through the teaching methods devised for all schools. By definition, therefore, they exclude from practical consideration many educational variables. Inherent differences exist among children, they admit, but only in small degrees. The curriculum, dominated until now by the so-called "hard" subjects, is designed to give all future citizens an intellectual foundation that is, in form, a traditional European one. This approach to education tends to give Soviet teachers a classroom control that appears complete.

Certain of their psychological research findings in the past are not the only explanation that we observe for this principle, however, and it is well to point out that Soviet psychologists have only recently been in a position to try out new methods in connection with a more diversified curriculum. As one Moscow educator pointed out to us in a discussion on methods, the researchers are not always successful in getting their results and viewpoints adopted in school programs. Psychologists and other researchers are busily engaged in work on such areas as development of the cognitive activity of pupils in the teaching process (especially in relation to the new polytechnic curriculum); simplification in learning reading and arithmetic skills in the lower grades; the formation of character and teaching moral values, including Soviet patriotism; psychological preparation of future teachers; the principles and methods for meeting individual children's needs (such as "self-appreciation"), in terms of handicaps and as regards a child's particular attitudes, peculiarities, and maturity; and understanding the internal, structural integrity of each school subject and its interrelationships with other branches of knowledge. These research activities are carried out under Soviet conditions and exemplify some of the major problems which educators there now face.

Although research goals are by and large established through planning, there is evidence of much purely experimental investigation, especially in educational psychology and education of the handicapped. It does seem to us, however, that limitations resulting from central control of research seriously handicap organic development; regional needs and individual creative innovations do not easily find accommodation in the official framework.

Soviet educators define their system as an all-round training whereby youth can participate in creating the conditions for a socialist, and, ultimately, a Communist society.[7] Such participation can become possible, they hold, only as students cultivate all the basic disciplines and only through a "steady rise in the productivity of labor . . ." which is linked closely with the educative process. School children and students are engaged in a total educational program which aims to teach them all the same basic subjects, morals, and habits in order to provide society with future workers and employees whose general education will make them socialist (Communist) citizens and contribute to their productivity upon learning a vocation (profession). A major task

[7] I. A. Kairov, *ed. Pedagogika.* (Pedagogy.) Moscow, Uch. Ped. Giz., 1956. Pp. 20–22.

now occupying Russian psychologists is to investigate the psychological conditions for improving the practical performance of pupils in prevocational school programs. Achieving this goal would have an effect on their productivity as adult workers.

Education and training in labor, therefore, form an important part of programs in educational research and in the regular schools. We have already noted some historical precedents in this direction during the late 19th and early 20th centuries. Soviet educators continued this concern for labor education, restating the theory in Marxist-Leninist terms.[8] After a variety of experiences in the early years of Soviet rule, the official study program for the general school became the "complex method," embracing all disciplines through a series of courses built on geographic schemes. The central theme of each phase or scheme was the work done by individuals and society to bring material surroundings into human service, and subject-matter was supposed to be introduced in order to develop understanding of the main theme. Socially useful work experiences were to be combined with this program. Many pedagogical and practical difficulties impeded its implementation, and the further development of this program, as well as Soviet pedagogy, was hampered by the reforms of the early 1930's, which came partly in response to the requirements of the 5-year plans.

Today, Soviet educators are enunciating new principles of labor education. While the new principles and programs use much the same terminology as that of former years, certain concepts and methods of implementation distinguish them from earlier practices. The basic philosophy of Soviet polytechnic education in the general primary-secondary schools is that education under modern technological requirements of society must include a basic understanding, in theory and in practice, of the operations of industry and agriculture. The philosophy postulates certain educative values to be derived from polytechnic training, such as understanding physical, natural, and mathematical laws; respect for labor activity and working people; and appreciation for complex processes in the course of material production. "The main task of the school is to prepare the up-coming generation for life,

[8] Lenin's original ideas on the subject are not extensive. A short summary of them is provided in N. K. Krupskaia, *Izbrannye pedagogicheskie proizvedeniia* (Selected pedagogical works), Moscow, Uchpedgiz, 1957, pp. 75–77. Krupskaia's own writings on polytechnic education are sizable.

for useful labor, to inspire in youth a deep respect for the principles of socialist society."[9]

These ideas seem to be transforming the Soviet general school into a major educative instrument for upgrading the technical-scientific competence of the entire generation. The school thus becomes a base for readapting the population, and particularly the young generation, to the changing techniques of modern industrial society. In this process, it appears to us that polytechnic education, combined with the traditional academic program, is emerging as a dynamic element in the philosophy of education in the Soviet Union.

Soviet educators point to the family and to youth organizations, as well as to the schools, as fundamental influences in the total education of children. Parents are encouraged to follow closely their youngsters' progress in school, to confer with teachers, and to serve on parent's school committees. Youth groups (the "Pioneers" and the "Komsomol") take the lead in stimulating and directing pupil initiatives, checking up on classwork and social performance, and applying forms of group punishment against recalcitrant members of the group (*kollektiv*).

The ideas and practices which we have reviewed here form a complex philosophy of education in which the authoritarian concept predominates. This philosophy at the same time recognizes flexibility and seems quite acceptable to changing conditions and views. Once a new concept is defined by the authorities, however, it is made to apply equally to all school districts and activities. Combining authoritarianism, elements of traditional education, faith in the power of education and in mass education, materialism, and educative values in polytechnic-labor programs, the Soviet philosophy of education stands today as a dynamic movement among educational philosophies of the world. Much evidence indicates changes in the philosophical foundations of education in the U.S.S.R., however, and it will require careful study in years ahead to determine what effects they have on educational philosophy.

SCHOOL ORGANIZATION

The political and economic contours of Soviet society largely determine the patterns of educational programs and organization. Planning and priorities are the leading factors here. At the base of the school system is a common program: a generally unified,

[9] Excerpt from a decree of the All-Union Komsomol Central Committee, in *Uchitel'skaia gazeta*, (Teachers newspaper), Feb. 28, 1959.

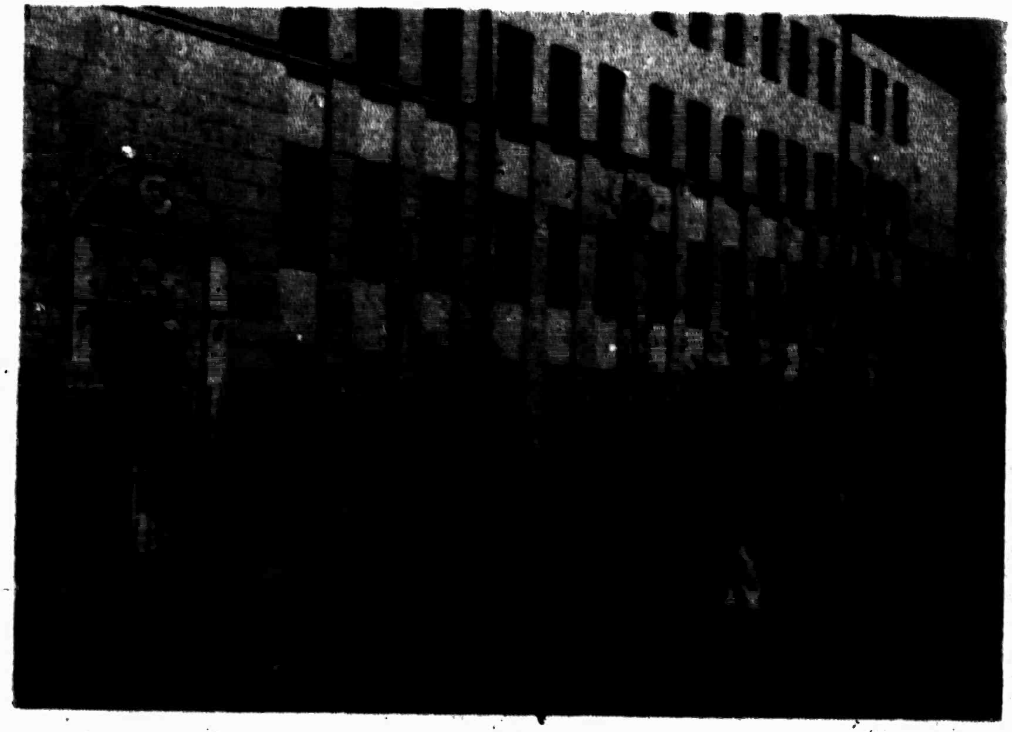

Figure 1-2.—Ten-year school, Zagorsk. Built in 1932.

universal, compulsory elementary schooling in grades 1–4[10] and a compulsory (nearly universal) 7-year education, or the "incomplete" secondary school.[10] This education provides the foundation for most all other educational programs, and normally all grades are housed in the same building. This latter principle applies also to the 10-year (or 11-year) school. Terminal in character, the 7-year school is followed by any one of several different kinds of schools which function parallel one to the other but under different administrative jurisdictions.[11] Thus, after receiving 7 or 8 years of general education, pupils may go into different forms of secondary education: 3-year general-polytechnical (leading to the university or to work in industry and agriculture), vocational (leading to industry or agriculture), technical (leading to industry, agriculture, and possibly higher education), semiprofessional (leading to industry or public services and possibly to a higher institute), and one of several forms of part-time general education. The last four educational routes may be anywhere from 6 months to 4 or more years in duration. The elementary-secondary boarding school is a new institution (since 1956) offering general-polytechnic education. Although we saw

[10] The 4-year elementary school is now in transition to a 5-year program; and the 7-year school is going into an 8-year program.

[11] *Soviet Commitment to Education*, pp. 5 ff.

education of this type, we did not make a special study of it.

Soviet educational policy requires a 6-day week for all school children. Saturday, however, is normally a shorter school day than the other days. The hours accumulated during a week, month, and year are impressive (see appendixes I to III for total hours per week from grade 1 and up). Over a 10-year period, the Soviet pupil spends approximately 10,600 hours in class and regular school activities. Under the new 11-year program, the total is planned to be well over 12,500 hours.

At the higher education level, we see another fractionalized system, where large numbers of separate and specialized institutions train highly qualified specialists in a few narrow fields, in response to economic and cultural requirements. For example, the medical, pharmaceutical, and veterinary institutes are outside the great universities. They are operated separately and come under the joint jurisdiction of the Ministry of Higher and Secondary Specialized Education, and an economic or functional ministry, such as the Ministry of Health or Ministry of Ferrous Metallurgy. While the State University of Moscow houses the basic faculties (departments) in the life sciences, a specialized school like the Timiriazev Academy of Agriculture at Moscow trains specialists in agricultural science and conducts research. Hundreds of such specialized institutes exist, working in relatively narrow fields.

This separation and the high functional specialization of Soviet university-level programs exemplify both Russian philosophy of education and conditions for educational development in the U.S.S.R. To help form a bridge between the foundational, theoretical training provided in the universities and the applied, specialized training given in the many institutes, there are the national (U.S.S.R.) Academy of Sciences, with its affiliates (such as the Siberian Branch), and the many Republic academies of sciences. Along with the higher education Ministry, these academies are responsible for planning and coordinating the theoretical and applied fields of scientific research. In the various departments (each grouping many disciplines) and many institutes of the Academy, the leading questions of science and methodology of research are considered. The leading members of the Academy are simultaneously the outstanding members of the university faculties. In such ways the Academy guides the scientific endeavors of the nation. A series of lesser academies responsible for the professions, such as education, fine arts, medicine, and architecture, perform similar functions in their respective fields.

Central Planning, Controls, and Methods

The Soviet economy has been geared since 1928 to a series of 5-year plans and now is engaged in an ambitious 7-year plan (1959 to 1965). These plans have consistently emphasized heavy industrial production, and even the new 7-year plan envisages 70 percent of total investments for the heavy industry sector.

The demands on the schools are closely related to these plans and emerge from decisions made by the State Planning Committee's (Gosplan) educational department. The various educational agencies must implement these plans, and the laws on which they operate provide the directions for meeting planned manpower needs. It is because of this planned development that Soviet educators are able to say to foreign educators that in the U.S.S.R. there are "no shortages" of specialists and teachers, since each succeeding year requires the training of specific quantities (quotas) of personnel.

To implement the planned training programs, two orders of control are exercised. The first is essentially political, drawing its authority from the central organs of Party and Government. The main operative agency for general education in each republic, the ministry of education, has central powers over all the school districts in the republic. The curriculums that it establishes are obligatory for all schools, so that the number of hours devoted to chemistry in a 10-year Moscow school will be the same as that in a 10-year school at Irkutsk, Siberia, other things being equal. This latter practice is control of the second order: educational control. Through its published curriculums, textbooks, methods manuals, and examination booklets the ministry controls the day-to-day work of the schools. An elaborate inspectorate system verifies from time to time a school's performance in every subject and activity.

PRINCIPLES AND METHODS OF INSTRUCTION

Principles of the teaching process provide a set framework for classroom teachers and are considered obligatory for them to observe. These basic principles were announced by the highest Government authorities at the outset of the major reforms in Soviet education in 1931–1932.[12] In accordance with these requirements, definite methodological solutions have been provided

[12] See M. M. Deineko, *comp., Spravochnik direktora shkoly* (Manual of the school director), Moscow, Uchpedgiz, 1955, pp. 17–31; also, *Biulleten' Narodnogo Komissariata po Prosveshchenilu R.S.F.S.R.* (Bulletin of the People's Commissariat for Education of R.S.F.S.R.), 1932, No. 49, Article 638, Sept. 5, 1932.

over the years for each subject. The major feature of the Soviet curriculum is the parallel method of presenting subject matter, both internally with respect to each discipline and externally with respect to interdisciplinary relationships. While this feature appears strongest in the fields of mathematics and the sciences, it is used to some extent also in the social sciences subjects.[13] By this method, facts and skills are learned about two different areas of a subject, such as mathematics, during the same period of instruction (that is, the same term or semester). Similar learning activities occur in physics or in geography, and the knowledge acquired in each of these subjects may also be related to knowledge or skills acquired in another discipline.

As we have already pointed out, Soviet pedagogy has a distinctively traditional or "essential" character as far as form is concerned. Content is another matter.

One of its cardinal principles is that "the development of abilities is impossible without a systematic mastery of scientific knowledge."[14] In practice this means learning prescribed amounts of data through emphasis on drills. The construction of the curriculum and the main body of teaching methods sharply reflect this principle and are representative of long-established practices of European education. Learning is developed through individual, separate subjects in systematic, logical, and interrelated forms following the elementary grades (1–4). Sequences are carefully worked out for each subject, normally based on 2, 3, or 4 hours of instruction per week. Certain "hard core" subjects, like the mother tongue and mathematics, are taken 6 or more hours per week until the high school level.[15] Soviet educators strongly maintain that each subject has its own, distinct body of knowledge which must occupy a corresponding place in the general curriculum. Teaching concepts that advocate merging of disciplines into such integrated courses as social studies or general science are shunned by them. They do not use any unitary measuring device for curriculum analysis or construction, such as the American Carnegie Unit. Subjects are given different emphases according to the values, both educative and utilitarian, that officials responsible for educational plans determine appropriate to their society's needs and schools' tasks.

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[13] See examples given in Bruce R. Vogeli, *The Mathematics Program of the Soviet Secondary School. Its Status and Innovations.* Unpublished doctoral dissertation at the University of Michigan, Ann Arbor, 1959.

[14] Kairov, I. A., *Pedagogika* (Pedagogy), p. 94. It is not intended here to discuss the problems of defining what is "scientific knowledge" in Soviet contexts, but rather to point out a governing principle within the Soviet framework.

[15] See appendix I, table B, p. 219.

THE LESSON PLAN

The heart of teaching each subject is the daily lesson plan. Every hour of every subject has its planned instruction or activity, worked out in detail in writing by the teacher in accordance with the requirements of official syllabuses (*programmy*) and texts. All topics in the syllabus are supposed to be covered in class, and the textbook serves as the main instrument or aid.

The lesson plan provides the basic academic work of the class. It should be so constructed that the following major aims of the lesson are achieved:

1. *Clear objectives*—Pupils must receive factual data which enable them to acquire precise impressions and understandings; they must see relationships between phenomena, theories, and laws; they should be able to distinguish type-processes and acquire the habit of doing this; they should be trained to notice lacunae which may occur in a body of given knowledge.
2. *Union of the formative and developmental tasks in education*—Through rigorous study of subject matter (especially the sciences), pupils should understand the materialistic basis of the world, the class struggle in social development, and the ideals of communist morality; teachers must constantly develop the thinking, memory, awareness, discipline, and volitional qualities in children and inculcate habits of orderliness.
3. *Appropriateness of educational materials*—Pupils' ability to perceive ideas is strongly dependent on the material aids used in education; teachers must carefully select the correct and most useful means for impressing upon children new and related facts.
4. *Collective unity of the class*—Each teacher's individual qualities must be used in the lesson so as to get the entire class to succeed in its assigned work; the teacher strives to consolidate knowledge already learned by pupils, to improve their ability to acquire more, and to inspire all children to pull together in mastering the subject.

Along with the work of the daily lesson plan, homework is assigned in varying amounts, from the second grade up. Whenever possible, teachers relate assignments to the problems of everyday life and to environmental occurrences. From grade 5, homework is more closely related to the regular lesson plan and actually forms an extension of it. Ideally, home assignments are not to exceed 30 minutes for each main subject. Depending on the grade level and the number of times per week a subject is taught, homework varies from 2 to 4 hours a day, making an average total of 16 to 17 hours per week. Some Soviet educators with whom we talked were admittedly concerned about the amount of time pupils put into home assignments, and these educators were striving to improve classroom methods so as to reduce the homework load. They feel that the better training in both subjects and methods which a teacher receives will enable him to

enrich the learning process in class and thus lessen the load carried in after-school hours. Inservice training programs are playing an important part in this effort. One geography teacher in whose class the writers spent some time had eliminated all homework in world geography. Methods such as class projects in political and economic geography covered the prescribed subject matter in a way that left no work for outside completion.

In all the classes we visited, lecture by the teacher and recitation by pupils on specific topics assigned from the lesson plan were the main teaching methods employed. Particular examples of this practice will be found in subsequent chapters dealing with various teaching areas. Possibilities for pupils' voluntary expression and participation are limited; the essential feature of Soviet classroom pedagogics is that the pupil must master the prescribed topics and be able to perform correctly what is given or required in the textbook.

MARKING SYSTEM

The marking system used in Soviet education is a unified one consisting of five number values. These standards have been used since 1944. Briefly, the values for each number-grade are as follows:

5—Means that the pupil (or student) has acquired an exhaustive knowledge of the subject matter, according to the program (syllabus); he has solidly mastered and understands the material precisely; in oral or written examinations, the pupil provides correct answers to all questions, works independently, applies facts to practical situations, and employs correct language in all forms of expression.

4—Means that the pupil knows all the required subject matter in the program; he has grasped and understands the material well; in examinations, he answers questions without difficulty, can apply knowledge practically, does not make serious mistakes, and employs written language with only minor mistakes.

3—Means that the pupil commands the fundamentals of the subject matter as required; in applying facts to practical tasks he has some difficulties which are overcome with moderate aid from the teacher; in spoken and written expression he makes mistakes.

2—Means the pupil reveals ignorance of most of the required subject matter; he answers only leading questions coming from the teacher; he makes numerous, serious mistakes in written work.

1—Means that the pupil is completely ignorant of the subject matter.

No arithmetical averages of a pupil's grades for all subjects taken in the year are made by Soviet educators, and the level of performance reached at the end of the year determines the grade. Pupils who obtain marks of 5 in *all* subjects in the curriculum are named gold medal winners; those who receive marks of 5 in

all the final exam subjects and 4 in no more than three other subjects are named silver medal winners.[16] Both categories of students earn special academic privileges with respect to entrance into higher institutions of learning.

Children are also graded on their personal conduct, inside and outside the school. A mark of 5 is given for normal, satisfactory conduct. When a pupil violates rules and receives a 4, the school's educational council takes note and watches for any further violation. Should a serious infringement of normal behavior occur, a 3 is given, in which case a pupil may be subject to dismissal from the school. If a child does not correct his behavior after initial violations, and becomes subject to a 2, he will be expelled by the educational council. This latter decision requires approval by the district educational department.

One example of class grading observed by the writer was the marking given for reading. The fourth grade class was asked to turn in the book to an unfamiliar text. The first child called upon read fluently one paragraph and then was asked questions by the teacher on the passage for comprehension. With some hesitancy the pupil answered the questions satisfactorily. The teacher recorded a mark of 5 and spoke it loud enough for all to hear. A second pupil, reading a new paragraph, had some difficulty with words and did not completely satisfy the teacher with answers to questions about the text read. This pupil received a 4. A third child read a third passage with marked ease and much expression. She was able to retell the part of the story (from Jules Verne) without any difficulty. This pupil received a 5.

Fourth grade Russian language work is graded, according to an official statement on marking,[17] in line with the following standards: for a 5, in written work, the pupil must clearly understand the story in the text; relate its content faithfully and without factual mistakes or substantive imprecisions; observe sequence; have no defects in the use of words or construction of sentences; and have no more than one error in punctuation. In mathematics for grades 8 through 10, for a mark of 5 the pupil must carry out written work completely and correctly, including the various steps in reaching answers and the giving of proof wherever appropriate. A 4 is given when there are one or two mistakes in written assignments.

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[16] In 1959, final exams at the end of secondary school were required in Russian literature, algebra, geometry, physics, chemistry, history, and a foreign language.

[17] M. Deineko, *op. cit.*, pp. 249 ff.

In inspecting a number of school children's workbooks (copybooks) containing regular written work and quizzes, we noted that in the main the marking standards as established by Soviet educational authorities are maintained.

In school corridors and classrooms, one sees many posters and banners carrying quotations and slogans from Government and Communist pronouncements. Many of these quote Lenin, some Marx, and their apparent purpose is to inculcate on pupils the beliefs expressed in the quotations. For example, in an eighth grade biology class, we observed these two posted on the walls: "The human mind has discovered much that is unusual in nature and is discovering still more, thereby increasing its power over nature." (Lenin) "Philosophy merely explains the world in various ways, but the conclusion of the matter lies in the fact that the world will change itself." (Marx) In a polytechnic laboratory in physics, the following quotation appeared in large yellow letters on a red banner: "Communism—it is Soviet power plus the electrification of the entire country." (Lenin)

These and other quoted sayings from Communist leaders appeared to be aimed at invoking in young people a strong desire to understand and to master their material environment. In certain quotations, a clearly political as well as philosophic indoctrination was evidently intended.

OUTSIDE SCHOOL ACTIVITIES

While the classroom teaching process exemplifies the essential features of Soviet educational philosophy and methods, another important area of education and culture lies outside the regular school program. This area is the Pioneer organization with its many clubs and district or municipal "palaces." Existing separately or parallel to the school system, it nonetheless has very close ties with school programs. Adult leaders in the Pioneer activities come mostly from the teaching staff of the local schools. This relationship provides for a direct bridge between educational work in both school and club.

Every school participates to some extent in forming "circles" (clubs) at the local Pioneer house. Children with expansive interest in developing knowledge and skills are encouraged to join the Pioneer organization and to participate in the club activities. These activities may be built around a particular subject, like literature or chemistry, or around some problem in home-making or industry. An important aspect of the program would seem to be the emphasis placed on child interest and self-expression.

This feature differs markedly from the intensely subject-centered teaching we found in the regular school classes. Activities which we saw going on in the Pioneer Palace in Tbilisi, Georgian S.S.R., for example, indicated there are broad opportunities for children desiring to pursue special interests under the guidance of experienced teachers and specialists. We observed musical and dance performances both in Tbilisi and in Moscow that attested to the marked success of the Pioneer program in helping youngsters to develop their particular talents and to express cultural traditions that make for human individuality. Part of the Pioneer activities, on the other hand, concern moral and ideological up-bringing in line with patriotic and Communist principles, designed to inspire collectiveness and loyalty.

Figure 1-3.—Children waiting for school rally, Moscow.

PEDAGOGICAL AND EDUCATIVE LEADERSHIP

There are two concepts of school management besides what can be normally called administration (functions of director, assistant directors, educational council, etc.) that bear directly on pupils' progress and the success of the school program. These concepts are the respective roles of the "grade leader" or leading teacher *(klassovoi rukovoditel')* and of the special "tutor" or educator *(vospitatel')*. In order to comprehend these terms, one may well distinguish that which, in American practices, pertains

to academic and instructional matters from that which pertains to character formation and upbringing. Calling the first category "pedagogy" and the second "education," one is able better to see the distinction which Soviet educators make particularly with regard to the concept of "tutor" *(vospitatel')*. As we shall see, both the class leader and the tutor have functions which are distinctly educative under these definitions.

Each grade from the fifth up has its grade leader who has special responsibility for promoting the overall success of the school program for that particular grade. This leading teacher normally stays with a grade (embracing several classes or groups) over several years after once having been assigned to it. He encourages companionship, hard-working attitudes, and a spirit of purpose on the part of all children. The leader becomes well acquainted with his charges and knows how best to work with them, who need special encouragement or help, etc. Appointment to this position is made by the school director (principal) from among the best qualified and most experienced teachers.

The grade leader's specific and most important duties include: verifying that the pupils' learn the "Rules for Pupils;"[18] following the daily school work, activities, and duties of pupils; striving to inculcate a sense of grade unity and school pride; checking on the academic load, including homework, required of all children; holding occasional grade meetings to discuss common problems; scrutinizing pupils for their aptitudes, interests, problems, and initiatives, as well as helping them in meeting or responding to these various needs and interests; organizing extra-curricular (including outside school) functions; and developing relations between school and parents, including preparations for the selection of pupils for different school or occupational programs upon completing 7- and 10-year schooling.

The leading teacher is required to draw up a regular plan for these various activities, either on a quarter or term basis. He or she is obliged to follow this plan and to report on the results of the program at the end of each school year. The work of the grade leader forms an important support of the school director's administration, and he too is required to report annually on the progress of his school program.

The office of tutor *(vospitatel')* appears to be a new one along with the development of boarding schools in Russia. Besides his regular teaching assignments, the tutor's role is to pro-

[18] See U.S. Department of Health, Education, and Welfare, Office of Education. *Education in the U.S.S.R.*, Washington, U.S. Government Printing Office, 1957. P. 64. Bulletin 1957, No. 14.

mote among children character-building activities consistent with Communist social and moral aims. These activities, we were told, should develop self-reliance and self-confidence, individual skills and talents, and respect for human values and for the "collective" (*kollektiv*, or group). The tutor's activities are mainly concentrated in after-school hours, when he works closely with the Pioneer and Komsomol organizations in developing programs for cultural enrichment and ideological upbringing. One tutor, who held the rank of senior tutor, with whom the writers spoke at some length, was a geography teacher in the regular school program. This man appeared to be an extremely able person. He holds a university-level degree from the Lenin Pedagogical Institute which, he was quick to point out to us, used to be the Second Moscow State University. He had 16 years of experience in teaching, was a singer and musician, and apparently had a fine personality. We felt that here were some qualities evidently sought in selecting a person for the new job of school tutor.

This tutor and the pupils put on a "talent" show for us which, we felt, merited particular praise for its organization, development of abilities, and spirit of comradeship. The tutor himself led and participated in parts of the program. We observed his conduct of an eighth grade class and were impressed with the teaching skills he employed.

PUPIL PROMOTIONS

As indicated earlier in this chapter, evidence suggests that nearly all pupils manage to pass the academic program. Only occasionally did we notice children obviously too old for their grade. This information is corroborated by findings of other careful observers of Soviet schools.

While precise data on the overall success and promotion of children in the U.S.S.R. are not available to us, it seems useful to report our findings in some schools. In the village school at Gorki-Leninskie near Moscow, which is now an 11-year school developing a full polytechnic education program, we were told that 80 percent of the graduates of the 7-year program go on to the upper grades (8 through 10 and now 11). Those who do not go on and decide to go to work can continue their education in a vocational school or in evening classes, correspondence programs, or special schools for working youth. These latter three programs lead to an academic high school certificate. Graduates of the 10- and 11-year programs who go on to higher education amount to about 30 percent of the graduating class. Not all within

this 30 percent can, however, be enrolled in the day programs. A little less than half of them will be admitted on an evening or correspondence basis. Some graduates go to 1-year vocational schools in agriculture, where on completion of the courses they will receive a trade specialty (such as machine operator) which qualifies them for a certain wage. In a school in a Georgian town near Tbilisi (southern Caucasus), 28 percent of the 7-year graduates went the previous year (1958) into vocational and technical schools, while the other 72 percent continued academic education in the eighth grade.

At 10-year School No. 14 in Zagorsk, a city of some 50,000 people, 90 percent of the pupils normally go on to the eighth grade. Upon graduation from grade 10 in 1958, about 20 percent enrolled in institutions of higher education. This school had an enrollment in 1959 of 1,500. In a smaller, 7-year school near Zagorsk, 17 pupils graduated in 1958. Of this number, 13 went on to the eighth grade, 2 enrolled in a vocational school, and 2 others went to work. In Moscow 11-year School No. 16, nearly 100 percent of the 7-year graduates continue their education into grade 8. From one class of 31 students completing grade 10 in 1958, 14 were accepted by institutions of higher education. From among 70 graduates of grade 10 at School No. 57 in Kiev, 34 enrolled in day programs of higher education, while the others are working but continuing their education in part-time programs.

These samples of promotion ratios taken at random substantially confirmed information later given us at the Ministry of Education in Moscow regarding pupil advancements. We were told that in urban regions (including the rural environs of major towns) between 70 and 80 percent of the youngsters go on to secondary school after grade 7; and that in the farming or rural areas, the figures vary but are around 50 percent. A small percentage of pupils today do not complete the seventh grade.

Statistics published by the Soviet Government in recent years do not give us enough information to speak with authority about enrollments as percentages of total age groups. Until official data collected during the recent Soviet population census become available,[19] it is unwise to attempt to give precise figures on how many Soviet children out of a specific age group are enrolled in various educational programs. Information given to us in the

[19] Cf. *Vestnik statistiki* (Journal of statistics), Moscow, No. 5, 1959. Additional statistical data, released in February 1960 (*Izvestiia*, Feb. 4, 1960), can assist in further analyses of enrollment and promotion developments.

U.S.S.R. and other data enable us to point to the general directions of pupil promotions. From our visits in the western regions of the Soviet Union, it appears that there about half of the eligible age group is enrolled in the upper grades of 10-year (some 11-year) programs. Another not insignificant proportion is enrolled in secondary vocational and technical schools of various types. These proportions are not precise, and we were unable to have them verified. Pertinent to these considerations are the facts that approximately one-half of the entire Soviet population is rural, and that one-fourth of all children in the elementary grades (1 through 4) attend separate, 4-grade schools. As of 1955, 65 percent of these schools (rural and urban combined) had 40 pupils or less, and 57 percent of them had but one teacher. It is apparent from these data that the 10-year school, which incorporates all grades, has not yet become available to significant portions of the population. While some observers indicate that no more than one-third of all Soviet children have been going on to secondary education, we feel that this estimate may be somewhat low and that it likely has been closer to one-half. Recent changes obscure this picture. In either case, mass education now appears to be in effect in the U.S.S.R. The degree of success that Soviet teachers are having and will continue to have with their principles and methods of teaching will determine the level and quality of education in this mass system.

Problems and Changes in Soviet Education

The unified school system and curriculum produce kinds and degrees of uniformity and conformity that are quite unfamiliar to an American observer. At first, one might think that here is an educational structure without major problems. Looking at the day-to-day pedagogical performances in the classrooms, our reaction was that this description of the situation appeared somewhat correct. We did, however, sense immediately a certain formalism in the school's learning exercise, which provided no indication that children develop skills to use knowledge. Pioneer work affords this opportunity for some children, however. The plan of studies, outlines of courses (syllabuses), official textbooks, and daily lesson schedules all provide ready-made devices for teacher control over the learning process and for measuring the amounts of information acquired. Teachers know their methods, pupils are eager to learn, and parents (especially many of those

who received little education themselves) are insistent that Ivan go to school.

The picture is not so calm as it first appears, and many Soviet educators with whom we talked discussed quite frankly what they thought was wrong with their schools. Studying their comments and following their educational publications as well as announcements by Government leaders in the U.S.S.R., we have been able to identify some of the major problem areas in Soviet education and the general direction in which it is moving.

Since the last major reforms initiated during 1931–32, the Russian general school has been primarily concerned with developing a strong academic program. This concern centered on the subjects whose mastery provided a necessary foundation for higher education, especially in mathematics, physical-natural sciences, and the mother tongue. Educational research aimed primarily to provide solutions to methods problems in subject-matter teaching, and to disseminate its findings and the experiences of the best schools to the field. With the various manpower needs, regulated to planned quota systems, this policy appeared to be satisfactory until recent years.

New problems arose, however, in connection with the economic, social, and intellectual development of the country. Briefly, these problems are: An unbalanced curricular structure, which requires all pupils to take the same subjects throughout the 7- and 10-year school programs; swelling enrollments in secondary education during the period 1950–1957; an impending fall in the age-group leaving schools for productive activities in society; unfavorable psychological attitudes of youth, especially in regard to occupational training and physical labor; need for improvement in selection procedures and in evaluating pupils' achievements; and need for providing for individual children's differences. We saw evidences of certain of these problems in the schools, spoke with Soviet educators about them and others, and have followed discussions in the Soviet press concerning some of them.

CURRICULUM

Leading Soviet educators in the Pedagogical Academy and also some school principals feel that, in the main, the old programs of study[20] constituted too heavy a load for Soviet youngsters. Obvious needs have arisen to facilitate the acquisition of mathematics, sciences, and technical drawing to lighten the load for specific time periods, and to reduce the program in social studies-

[20] See appendix I, table A, p. 218.

humanities. In discussing this matter in the Institute of the Theory and History of Pedagogy, the Director was careful to point out to us that the overall aim is *not* to reduce the quality of education, in the academic sense, but to make learning easier and more accessible to all children. The new curriculums being worked out are planned to introduce much more practical work than was previously offered, and at the same time they will lessen relatively (but *not* absolutely) the load of academic subjects as compared to the old curriculums.

Curriculum development is also going on in order to teach educative values of practical work (in shops and agricultural plots) and of production work (in shops and factories, and on farms). Pupils will spend many more hours than heretofore on activities involving manual as well as intellectual skills. Backgrounds for this development are discussed later in this chapter.

ENROLLMENTS

As the Soviet Union moved toward universal 7-year education in the postwar years, pupil enrollments in the upper secondary grades began to swell way beyond the numbers normally required to meet higher education quotas. From 1950 to 1955, for example, the number of students in grades 8, 9, and 10 of the regular day schools increased by 350 percent (from 1.5 million to 5.2 million). While graduates from these grades during that period mounted to 1.5 million a year, annual first-time enrollments in universities and institutes have been held consistently to around

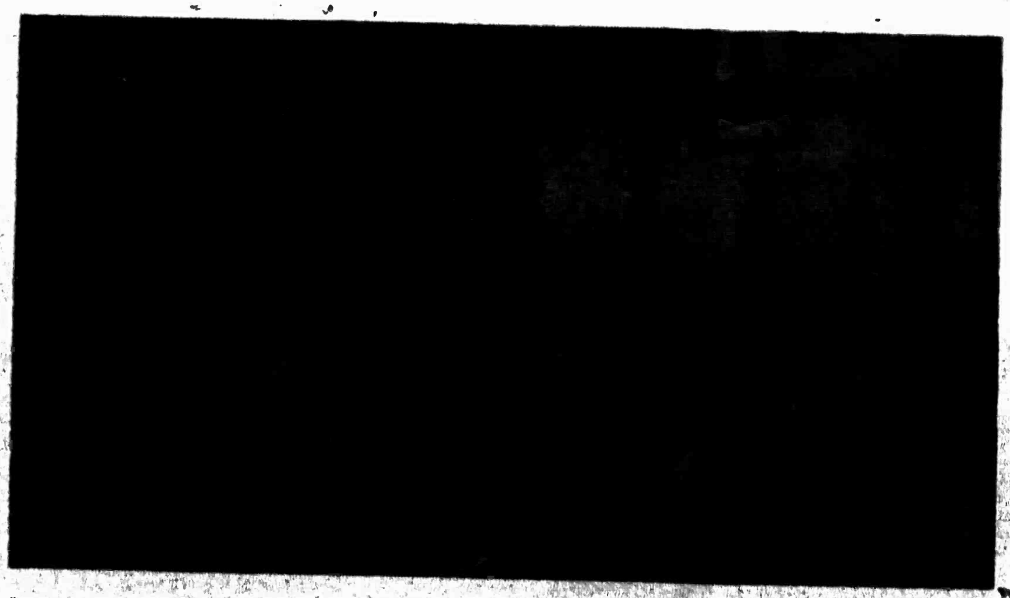

Figure 1-4.—Manual arts work in second grade.

150,000. In some anticipation of the need to supply future secondary school graduates with some specialized knowledge or skill, the XIX Congress of the Communist Party of the Soviet Union (C.P.S.U.) in October 1952 passed a resolution calling on the schools to devise ways of changing their programs: "With the aim of raising further the socialist, educative significance of the general educational school, and of securing for pupils who fulfill secondary school conditions the free choice of a vocation, it is necessary to proceed toward effecting polytechnic instruction in secondary schools and to take measures necessary for the transfer toward general polytechnic education."[21]

Educational administrators set to work on this problem and also on efforts to direct academic high school graduates to other programs. New postsecondary vocational-technical schools were opened in 1954–55 to train skilled workers, in addition to the already existing network of technicums and other specialized institutions. These latter two types, formerly organized mainly for receiving 7-year school graduates, expanded their facilities for offering training to persons with 8 or 9 years of education and to graduates of the 10-year program.[22]

In very recent years, however, upper secondary enrollments in the regular day schools have fallen off rapidly, to the point where in 1958–59 the number fell to 3,400,000.[23] This drop is primarily due to the very low birth rate during wartime conditions (1941–45), compounded by heavy losses of life, both military and civilian.

LABOR MARKET

The drop, after 1957, by one-half in the number of youths of working age will have an effect on numbers available for industrial and agricultural employment during 1960–1965. With this situation imminent and with needs for technically literate youngsters ever on the increase, the new polytechnic training program is being introduced at a time when it can help meet these problems and when enrollments are lower and more manageable. Low

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[21] M. Dolnsko, *Op. cit.*, p. 186.

[22] For example, see programs listed for the Moscow region in *Kudu poiti uchit'sia; spravochnik* (Where to go to study; a manual), Moscow, "Moskovskaia pravda," 1956, pp. 121–208; also M. Dolnsko, comp., *Gde poluchit' spetsial'nost'; spravochnik* (Where to receive a specialty; a manual), Moscow, Uchpedgiz, 1955.

[23] Over 1.2 million others were enrolled in special schools for working youth and 1.1 million for adults, which offer complete academic programs. *Narodnoe khoziaistvo S.S.S.R. v 1958 godu.* (The national economy of the U.S.S.R. in 1958.) Moscow, Gos. stat. izdat., 1959. Pp. 114–117.

enrollments mean too that the costs in providing a technical basis for a full polytechnic program would not be so heavy as they would be at a time of normal enrollments.

The relationship between planned economic goals and the need for greater productivity is also evident in schools' polytechnic programs. Agreements between school districts and local economic councils of the Government provide production quotas for school shops on items such as grease cups, cabinets, sacks, boxes, etc. Rural schools produce marketable crops or animal produce. During the coming period of manpower decline, schools will thus be contributing something to the national economy.

YOUTH ATTITUDES

As more millions of youngsters took the academic curriculum preparatory for higher education, aspirations for entering institutions of higher education increased accordingly. The annual first-time enrollments at the university level remained practically constant, however, and opportunities for secondary school graduates to obtain a higher education failed by far to meet the number of eligible candidates. This situation had several effects. It intensified the competitions for entrance, which in turn led to abnormal and incorrect practices, by some educators and parents, that the Soviet Government has condemned.[24]

It produced some disillusionment among youths who place high value on admittance to higher institutions as a direct path to important state service, to prestige in society, and to high material rewards. Many thousands of young people preferred to wait for future openings in enrollments rather than to take manual labor jobs in industry and agriculture. Physical labor was looked upon as degrading.[25] Others, however, joined vast development programs such as those in the new agricultural districts of Soviet Central Asia.

As one corrective measure, work experience has become more and more important in relationship to access to higher education in recent years. Since June 1955, entrance has been preferentially granted to those who have acquired "not less than 2 years' experience in . . . the national economy and culture, and have been demobilized" from military service.[26] Medal holders, who are

[24] See N. S. Khrushchev, "Ob ukreplenii sviazi shkoly s zhizn'iu i o dal'neishem razvitii sistemy narodnogo obrazovaniia v strane" (On Strengthening the Ties of School with Life and on Further Developing the Country's System of Public Education), in *Izvestiia*, Sept. 21, 1958, p. 2, referring to such things.

[25] See, "Psikhologicheski gotovit' detei k trudu" (Psychological Preparation of Children Toward Labor), in *Uchitel'skaia gazeta*, December 4, 1958, p. 2.

[26] L. I. Karpov *and* V. A. Severtsev, *ed. Vysshaia shkola.* (The higher school), Moscow, "Sovetskaia Nauka," 1957. P. 39.

waived from taking entrance examinations, have not thus far been hindered by this provision. Soviet officials said that in 1957 about half of the first-year enrollees had had required work experiences (the larger proportions of those lacking experience were in scientific fields). In the fall of 1958, 68 percent of the new students had satisfied the work requirement. The Government's aim is to reach 80 percent.

Another effect of the old curriculum on youth, intimately related to the above factors, is to leave them unprepared for occupations in the national economy. Although they receive some basic education in the sciences and humanities, this knowledge is substantially unrelated to practical needs of industry, commerce, and agriculture. Additional training is required if they are to become productive persons in a new industrial society which is ambitiously forging ahead. More time and investment in training them cost the Government additional resources that could be used in other ways.

Apparently related to the problems in youth attitudes is a concern voiced by top Government leaders that some institutions of higher education are practicing abnormal entrance policies, particularly in the large urban areas. There is evidence that in these areas an unequal distribution of university enrollments has grown up with respect to the socioeconomic background of the students. The head of the Communist Party and of the Soviet Government himself, Mr. Khrushchev, has indicated that, for example, in the higher institutions of the Moscow area, "30-40 percent of the students are children of workers and peasants. The rest of the students are children of employees, the intelligentsia. Of course, such a situation is clearly abnormal." Criticizing the effects of parental influence in selecting young people for the university, he said that, "It is necessary that each young man and each girl, independently of whatever position their parents occupy, prepare themselves for labor activity on grounds common for all. A son and daughter should know that daddy is daddy, and they ought by themselves, by their own labor, earn the respect of people, and not live on the credit of their parents' attainments."[27]

SELECTION AND DIFFERENTIATION

The presence of vastly greater numbers of children in their midst caused leaders in secondary education to reconsider methods for identifying skills and talents. One of the important

[27] See, *Izvestiia*, April 19, 1958, and Sept. 31, 1958.

aspects of the new reform and its research program, we were told, is to develop curriculums that will help youngsters decide what they should do in both school and later life, what type of occupational career to follow, and what skills to develop.

Soviet educators are also more concerned now than in the past with differences among children. Their research, corroborated by reports from teachers in the classrooms, show that children have different rates of learning, often indicate definite leanings toward one kind of discipline or specialty, and respond variously to the same experiences, forming different personality traits. Ways of stimulating individual pupils to feel a group solidarity while at the same time to appreciate their own qualities are being studied. A related problem concerns the ways in which pupils link their shop or production work plans and routines together—following through on a job by controlling and checking the steps in its execution.

All of these problems, and other minor or tributary ones, have in recent years led to a sharp increase in educational research efforts and to some major reforms in educational practices. These measures are influencing the entire structure of Soviet schools, from preschool education to university programs. Textbooks are being rewritten, teaching methods are changing, curriculums are being radically revised, and the philosophy of education itself is in the process of being reformulated.

Signs of these fundamental changes have been many. Research projects and findings in the Russian Academy of Pedagogical Sciences in 1954–55 showed that work was proceeding along lines to transform the general educational school.[28] In 1956, a new Research Division for Contemporary Education and Schools Abroad (comparative education) was established in the Academy to study systematically foreign education.[29] One of their main current projects is studying programs of industrial-agricultural arts and practical training in schools abroad. During 1956–1958, Soviet educational research conducted a large program of experimental classes in combining theoretical, academic instruction with productive labor exercises in school shops and at industrial and agricultural enterprises.[30] Aiming to teach in more concrete ways the theoretical-scientific bases of industry and agriculture, to

[28] For example, see research reportings in *Izvestiia Akademii pedagogicheskikh nauk R.S.F.S.R.* (Journal of the Academy of Pedagogical Sciences of R.S.F.S.R.), Nos. 58 (1954), 73, and 75 (1955), especially No. 58.

[29] See, V. A. Veikshan, "The Moscow Center in Comparative Education," in *Comparative Education Review*, June 1959, pp. 4–5.

[30] A list of experimental schools in the Russian Federation is given in appendix III, p. 226.

lead students toward solving important problems involved in production training and work routines, and to reinforce data learned about theories and through abstract thinking, this extensive research has provided considerable guidance to Soviet educators in their efforts to reorganize education. In the main, their experience has shown that, in subjects like mathematics, physics, chemistry, and biology, students following the old curriculum with its traditional teaching methods received larger proportions of top marks on examinations than did those following the experimental curriculums with polytechnic-production education. Students in the experimental schools, however, were able as a result of their practical exercises and work to solve problems and use their knowledge considerably better than students of the regular program. Furthermore, the experimental students formed better habits, performed laboratory assignments better, used richer language in their expression, and had a fuller command of technical terms. Student interest in their school subjects and their relationships to the economy increased. Many pupils who before had unsatisfactory records in some subjects improved markedly under the new methods. In the course of these experiments, teachers, researchers, and students were able to solve many new problems connected with polytechnic education. Soviet educators consider their experimental work in this area to be a major success, although they admit that there are many difficult pedagogical and organizational questions, not to mention the problem of materials equipment, which yet have to be worked out.

It was obvious to us, when observing polytechnic classes, that real educative values can be and are taught in this program, and that Soviet educators have made an important breakthrough into new educational terrain. New methods, new principles, and perhaps a new philosophy of education are being worked out. At the same time, some matters in which the State has a direct interest are also involved. Teachers and school directors say that they agree by contract to produce in their school shops certain quantities of goods or hardware which will be used in some enterprise or institution. In the recently published words of the Russian Minister of Education E. I. Afanasenko, the program of the schools is intimately related to the major task facing the entire nation: "acceleration of the technical progress in industry and construction."[31] Soviet educators, he states, must accept this task as the

[31] E. Afanasenko, "K rabotnikam narodnogo obrazovaniia Rosiiskoi Federatsii", ("To workers of public education of the Russian Federation"), in *Narodnoe obrazovanie* (Public education), No. 9, 1959, p. 11.

"key to the successful fulfillment of the 7-year plan" and to implement the measures for bringing school work close to real life, a problem which is "directly and immediately connected with the task of an all-round development of technical progress in our country. . . ."

On the political side, the policy set by the XIX C.P.S.U. Congress was reiterated by the XX C.P.S.U. Congress in February 1956, which called for school reorganizations that would put more practical exercises into the program, preparing youngsters better for life situations. A resolution was passed demanding creation of polytechnic education.[32] This new policy was coincident with that of establishing universal secondary education in the urban and rural communities.

In their official statements and writings, Government leaders have come out strongly in favor of the reforms and have substantially pointed out the way they should go. Particularly outspoken on the matter has been Nikita S. Khrushchev, Prime Minister (Chairman) of the Soviet Council of Ministers and First Secretary of the C.P.S.U. Central Committee. At the XX C.P.S.U. Congress, his major report pointed to the need for bringing school activities closer to everyday living requirements. In a major address in April 1958 to the XIII Congress of the Komsomol, and then again in his proposals to the C.P.S.U. Presidium in September 1958,[33] Mr. Khrushchev urged ever more radical measures for reorganizing education. That he and the Government thought that some Soviet youth had the wrong idea about education was evident in his statement: "A portion of those who finish the 10-year school unwillingly go to work in factories, plants, and collective and state farms, and some even consider that it is an insult to them."[34]

A major Government document on the problem was issued on November 16, 1958, jointly by the C.P.S.U. Central Committee and the U.S.S.R. Council of Ministers.[35] Embodying essentially all the recommendations contained in the Khrushchev proposals, the new directives emphasized that the economic and cultural development of the country requires greater numbers of youth trained not only in academic subjects but also in the technical and vocational lines useful in a growing industrial society. These

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[32] *Direktivy XX S'ezda KPSS po shestomu piatiletnemu planu . . . na 1956–1960 gody.* (Directives of the XX Congress of the C.P.S.U. for the sixth five year plan . . . in 1956-1960.) Moscow. 1956. Pp. 56–57.

[33] *Izvestiia*, Sept. 21, 1958.

[34] *Idem.*

[35] *Izvestiia*, Nov. 16, 1958.

are practical considerations which the Government and educators have decided to pursue if the labor force is to be replenished and if productivity is to increase.

These various initiatives culminated in the passage of a law on education by the U.S.S.R. Supreme Soviet on December 24, 1958, entitled "Law on Strengthening the Ties of School with Life and on the Further Development of the System of Public Education in the U.S.S.R."[36] This measure incorporated, in the main, the Government's recommendations of November 1958. Further legislation and decrees by the Republic Governments of the Soviet Union have since supplemented the basic law.[37]

For the 1959–60 school year, new curriculums have been published which place the schools on a path that will, over a 5-year period, substantially recast their curricular structures and educational goals.[38] The original proposals of the Soviet Government, made first in September and then in November 1958, were insistent on engaging *all* young people aged 15 and 16 in productive labor upon their completing 8 years of basic education. An exception was to be made for the gifted and talented youth, especially in fields of science and arts. This strong emphasis by the Soviet leadership on adolescents' participation in industrial and agricultural labor left little doubt about the Government's intentions for secondary education: The majority of young people would acquire high school education through part-time study programs.

While the final measures enacted by the various legislatures do not require so large a shift away from full-time secondary education, they do envisage a substantial remaking of the Soviet school structure. Furthermore, the expansion in part-time schooling which is now under way and the increase of enrollments in part-time programs indicate a slight trend away from mass day education at the secondary level, as compared to trends up to about 1957. Part-time enrollments during 1957–1959, for example, increased by 20 percent (from 1 to 1.2 million). Taken together, the changes in Soviet general education rank in importance and scope with the reforms initiated during 1931–32 by the Soviet Government, which brought about the 7-year and 10-year general academic school systems.

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[36] *Izvestiia*, Dec. 25, 1958. An analysis of the law and its main features appears in *Soviet Commitment to Education*, pp. 126 ff.

[37] See, for example, the law passed by the R.S.F.S.R. Supreme Soviet, in *Izvestiia*, April 17, 1959.

[38] New curriculums issued by the R.S.F.S.R. Ministry of Education are published in appendix I.

MAIN FEATURES OF REFORMS

While it is beyond the scope of this study to examine and interpret fully the developments that have occurred (which most likely will continue to occur), it is useful to point out some of the more salient aspects and trends.

First of all, the general educational school has changed its name from "school of general education" to that of "labor-polytechnic school of general education." Secondly, the period of compulsory, free schooling has been raised from 7 years to 8. While this latter provision increases the national level of universal education in the Soviet Union, it also represents a change in the national educational policy announced at the XX C.P.S.U. Congress in February 1956. That Congress called for general 10-year education to be established in the main in all urban and rural communities. Soviet educational authorities maintain that secondary education will, however, continue to expand, and that enrollments will double by 1965 as compared with 1959. In this calculation, account should be made both for the recent drop in school enrollments due to low wartime and postwar birth rates, and for the coming increase in youngsters of high school age born during the latter part of the 1940's.

A third structural change is the addition of an 11th year to the secondary school, whereby the upper grades become 9, 10, and 11 instead of the former 8, 9, and 10. This development is especially interesting, because it lengthens the period of total schooling at a time when the numbers of youth of labor age are decreasing, and because it is accompanied by radical curriculum reforms. These two aspects of the school organization problem are closely related to each other and also to curriculum developments in the lower grades.

Examination of table 1 will help in understanding these relationships. Data on the concentrations of school hours in the four subject areas have been determined over the period from the 1955–56 school year to the 1959–60 school year, including planned curriculum changes announced by the Soviet Government for the R.S.F.S.R. These subject-area concentrations are: *Humanities*—mother tongue, foreign language, literature, history, civics, geography, drawing, singing, and music; *mathematics-sciences*—arithmetic, algebra, geometry, trigonometry, biology, chemistry, and physics; *polytechnic education*—manual arts, industrial and agricultural knowledge with practical exercises in shops and on plots, socially useful labor, and production work; and *physical education*. Based on official curriculums for each school year (see

Table 1.—Trends in curriculum concentrations (1956-1960)

Subject areas and grades	1956		1958			1960				
	Concentrations in subject areas during grade period		Concentrations in subject areas during grade period		Percent change from 1956	Subject areas and grades	Concentrations in subject areas during grade period		Percent change from	
	Hours	Percent	Hours	Percent			Hours	Percent	1956	1958
1	2	3	4	5	6	7	8	9	10	11
All subjects						All subjects				
Grades 1–10	9,857	100	10,617	100	+7.7	1–11 (planned)	12,679 (planned)	100	+28	+19.4
Humanities						***Humanities***				
Grades 1–10	5,049	53.0	5,100	48.1		Grades 1–11 (planned)	5,367 (planned)	42.3	+6.3	+5.2
Grades 5–10	3,089	46.7	3,058	42.2		Grades 6–11 planned)	2,759 (planned)	35.0	−10.6	−9.7
Math.-Sciences						***Math.-Sciences***				
Grades 1–10	3,300	33.0	3,332	31.3		Grades 1–11 (planned)	3,700 (planned)	29.2	+12.0	+11.0
Grades 5–10	2,442	36.8	2,447	33.8		Grades 6–11 (planned)	2,465 (planned)	31.0	+.95	+.74
Polytechnic						***Polytechnic***				
Grades 1–10	848	8.0	1,403	13.2		Grades 1–11 (planned)	2,820 (planned)	22.2	+232.0	+50.0
Grades 5–10	690	10.5	1,172	17.0		Grades 6–11 (planned)	2,220 (planned)	28.0	+222.0	+89.0
Physical Ed.						***Physical Ed.***				
Grades 1–10	660	6.0	782	7.4		Grades 1–11 (planned)	792 (planned)	6.3	+20.0	+1.3
Grades 5–10	396	6.0	510	7.0		Grades 6–11 (planned)	440 (planned)	6.0	+11.1	−13.7

NOTE.—For analytical purposes, the grade grouping used at the secondary school level of the 1960 curriculum (planned) was arbitrarily made to cover grades 6 through 11, rather than 5 through 11, so that equal numbers of years could be compared for the different curriculums. Slightly higher figures in total hours for subject concentrations would otherwise be reflected for 1960.

appendix I), these data reflect the total hours accumulated in each discipline or activity, and they are substantially indicative of major trends in curriculum developments in recent years as well as forecasts of planned changes.

In adding a school year to the old program, Soviet educators are increasing the total primary-secondary schooling by 19.4 percent over the 1957–58 curriculum (used in 50 percent of the Russian schools during the school year 1958–59), and by 28 percent over the 1955–56 curriculum in Russian schools. The distributions made of these increases over preceding curriculums have been uneven with respect to various subject and activity areas. Heavily favored in the redistributions have been programs in the practical, labor, and production courses and experiences. In terms of *relative* changes in concentrations, the academic subjects have actually *lost* weight in the overall, even though in absolute terms the total numbers of hours devoted to them in the new curriculum have increased somewhat. Thus, while 2,822 hours of instruction and training have been added to the entire primary-secondary school program between 1956 and 1960, which is a 28 percent increase, increases have been moderate indeed in the traditional subjects, only 318 hours are being added to social studies-humanities (increase of 6.3 percent), no more than 400 hours going to math-sciences (12 percent increase). In the polytechnic subjects, however, over 1,900 hours are being added in the new program (232 percent increase). Definitive analyses of curriculum changes must await examination of new programs of study and more class visits. It is well to point out too that changes in total class hours are not necessarily indicative of how much more or less education will be given under new programs and new methods.

These alterations in program, with the heavy shift toward practical skills and knowledge, can be largely explained by the construction of the curriculum in grades 9 through 11; two-thirds of the time in these grades will be taken up by class work, including some basic theory related to polytechnic training, while one-third of the time will be entirely devoted to work experience and work related programs of one kind or another. From grade 6 on, pupils will spend an average of almost 3 hours out of 10 in technical and production related training. Soviet educators told us that it is not wholly clear to them yet just how some of the production training programs will be structured and administered, since they are still experimenting with various possible solutions. Nonetheless, their plans are to bring all secondary

Figure 1-5.—Work experience program in 11-year school.

school children into labor education and training experiences through the regular school program. The dimensions of this undertaking promise to make the Soviet Polytechnic school one of the most industrially and technically oriented schools of general education among modern industrial societies.

It is our view that it is too early yet to draw any firm interpretations about these announced changes and about trends in school enrollments and practices. These changes will be taking place in stages over the 1959–1965 period, and at the same time Soviet education continues to experiment and to be subject to alteration by ministerial decree. During the 1959–60 school year, the vast majority of 10-year and 7-year schools will be following the curriculums that have been implemented since 1957. Children in grades 1-5, in grades 9-11 at many experimental schools, and in grade 8 in a large number of 7-year schools will be following new programs of study in the Russian Federation. According to official data available to us, it appears that during 1959–60, approximately 6 to 7 percent of the secondary schools in Russia are to be operating on an 11-year basis with new, experimental curriculums. At the same time, an 8th year of schooling will be introduced in approximately 3 percent of the 7-year Russian schools. Changes seem to be taking place on a similar scale in Ukraine. Our observations of Soviet schools'

progress in shifting to new curriculums suggest that the best equipped and staffed schools will be the ones to change their programs first.

Based on evidence thus far published, it appears that the polytechnic school with labor experience will provide both the academic and the prevocational (polytechnic) education with which Soviet youth will make their way in Soviet society. It also seems evident that the nature of the 8-year school and the absence of a requirement that children continue on to upper secondary school will provide strong tendencies toward making the 8-year school a terminal one for many youngsters. Future developments will indicate the actual trends, and meantime many problems admittedly lie ahead for Soviet educators.

We feel that, depending on pupil selection and on teacher preparation, the introduction of much more polytechnic and labor education might change the emphasis of the overall program in the academic disciplines. Such a change might occur especially if enrollments steadily increase and the new 11-year school becomes a unified, mass, and somewhat comprehensive educational institution. The vast majority of pupils will, upon graduation, take employment in the economy, while a small percentage will qualify for institutions of higher education and postsecondary schools. Up until the decade of the 1950's, these latter institutions absorbed most of the high school graduate. That Soviet educators are thinking about ways to provide future academic enrichment programs is evident in plans, which they discussed with us, to provide special after-school classes in mathematics and the sciences. Some experiments in academic "track" programs have also been taking place in a few secondary schools, and certain Soviet educators suggest introducing a multiple-program secondary school of a comprehensive type.[39] They also speak of an eventual 12-year program in order to accommodate all youth.

It seems clear to us that the Soviet Union, on a mass scale, is now adjusting its educational system so as to make a general education with polytechnic emphasis available to all youth in the decades ahead. The "reform measures" appear to respond to economic needs and technical development of the country, and to retain thus far an academic emphasis about the same as in the 10-year program. The exact character of these measures will be known, however, only as they are implemented in the schools and authoritatively reported on.

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[39] N. K. Goncharov, "O vvedenii furkatsii v starshikh klassakh srednei shkoly" ("On introducing multiple-track education in the senior grades of secondary school"), in *Sovetskaia pedagogika* (Soviet pedagogy), No. 6, 1958, p. 12 ff.

CHAPTER II

Science and Mathematics in the General Schools

IT SEEMS NATURAL that, by virture of the materialistic philosophy espoused by the Soviet Government, great emphasis should be placed on the natural sciences and mathematics. This view not only is reflected in the curriculums in institutions of education, but it also pervades the thinking of those who are in charge of educational programs.

Everywhere we visited we were impressed by the fact that the Soviet people are convinced that their destiny is closely linked with science and technology. They are proud of their successes with Sputniks and Luniks. They praise the accomplishments of such world-renowned scientists as Pavlov, Lobachevskii, and Mendeleev. They accord great respect and prestige to their large number of present-day scientists who are making names for themselves and pushing Soviet science and technology to the forefront. It was not surprising to us then that, when we interrogated pupils in the schools that we visited, a large percentage of them wanted to become scientists and engineers.

Some Fundamental Soviet Ideas

While in the U.S.S.R., we had opportunity to discuss with leading educators the role that science and mathematics education plays in the schools of the Soviet Union. We wanted to learn from them what their views are on how much science and mathematics should be taught in the schools and how these subjects should be taught.

In our consultations with officials of the Russian Soviet Federated Socialist Republic (R.S.F.S.R.) Ministry of Education in Moscow and in discussions with researchers and teachers around the country we questioned the educational policy of requiring

all pupils in the regular 10-year school to complete mathematics through solid geometry and trigonometry, physics up to topics in atomic physics, and chemistry up to topics in organic substances. We expressed the opinion that, although such subjects are appropriate for future scientists and engineers, other subjects could perhaps be studied more advantageously by students planning different types of careers. Our Soviet hosts replied that they believed their academic program currently in effect was absolutely necessary for *all* pupils if they were to become cultured citizens. They pointed out that science and mathematics constitute only a part of the curriculum, and that not only should each pupil know of Newton and Faraday and their work, for example, but equally should they know and appreciate the contributions of Shakespeare and Goethe.

It was emphasized that Soviet educators do not believe in science survey or general science courses. They feel that the pupil must learn the fundamentals of every field of knowledge, and that courses in "general science" were inadequate because they did not give the pupils a sufficient knowledge of the fundamentals. Soviet educators say they are not surprised that other countries following this kind of instruction complain about shortages of scientists and engineers. They assert that there is no shortage in the U.S.S.R. of students who desire and are prepared to make careers in science and engineering, and they attribute this circumstance to the basic scientific training they were getting in Soviet schools. It seems appropriate to point out that the planned Soviet economy enables Soviet officials to state that they experience no "shortages" of trained manpower, since quotas assigned for them are normally filled.

In chapter I, reference has been made to the parallel method of presenting subject matter. This practice is especially evident in the teaching of science and mathematics. Soviet educators believe that there should be close integration in the teaching of these subjects rather than the presentation of them as discrete, independent entities. Thus, physics, chemistry, and mathematics are taught in each of the grades 7 through 10, and the attempt is made to have the concepts taught in one subject reinforce the concepts taught in the other subjects. Systematic study of physics and chemistry with the aid of mathematics is introduced at appropriate levels.

Even in instruction in mathematics the parallel method of presentation is followed. Algebra, geometry, and trigonometry, for example, are each taught in the 9th and 10th grades. By this

Figure 2-1.—Tractor driving in 11th grade.

method Soviet educators believe that pupils will understand these branches of mathematics and their interrelations more thoroughly.

RELATION TO POLYTECHNIC TRAINING

While chapter III goes into detail on the present Soviet emphasis on polytechnic education, it is well to point out that this trend is reflected in the science and mathematics programs in the schools. Everywhere we went we were told that one of the chief aims was to link education closer to everyday life. To achieve this goal every effort is made to teach as early as possible understandings of scientific principles so that pupils can then relate them to the polytechnic training they will receive in the workshops, in the factories, and on the collective or state farms. In our visits to schools and factories we were shown numerous instances where pupils were attempting to put to practical use theoretical knowledge they had gained in the classroom.

BROAD ASPECTS OF THE CURRICULUM

The curriculum of the schools is prescribed for all grade levels and is essentially uniform throughout the U.S.S.R. Science and mathematics play significant roles in the total instructional pattern, occupying 31.4 percent of the student's time in the complete 10-year school. Science and mathematics are also taught

in the vocational schools and the technicums, but not as deeply or as far as in the complete 10-year school.

The percentage of time devoted to different areas of study in the complete 10-year school[1] follows:

Curricular Concentration, Grades 1 Through 10

	Percent
Humanities and social studies	48.0
Science and mathematics	31.4
Polytechnic education[1]	13.2
Physical education	7.4

[1] Includes technical-drawing.

This breakdown of time devoted to various broad areas of study does not reveal the true importance given to science and mathematics because instruction in the elementary grades (1 through 4) is what might be called general or basic education, and the inclusion of these grades in the preceding computation tends to magnify the significance of the humanities and social sciences in the total curriculum. The following breakdown, using only grades 5 through 10, perhaps gives a more realistic picture of time allocation:

Curricular Concentration, Grades 5 Through 10

	Percent
Humanities and social studies	42.2
Science and mathematics	33.8
Polytechnic education[1]	17.0
Physical education	7.0

[1] Includes technical drawing.

Mathematics is regarded by Soviet educators as a very important subject. Of the total of 10,617 hours of instruction in the complete 10-year school, 2,023 hours, or 19.1 percent of the total time, is devoted to mathematics. Only Russian language and literature with 2,856 hours exceed the time given to mathematics instruction. Mathematics is taught 6 hours a week in every grade except the last half of grade 10, in which it is taught 5 hours a week.

Unlike schools in the United States, Soviet schools do not offer courses in chemistry, physics, and biology integrated into 1 year each. Instead they spread instruction in these subjects out over a number of years, beginning with biology in grade 4, physics in grade 6, and chemistry in grade 7. The number of hours devoted to these subjects at the various grade levels is shown in table 2. It is true, however, that much of the material taught in these

[1] Curriculum was that in effect prior to the changes announced in 1959. See appendix I, table B.

courses is taught in U.S. schools at equivalent grade levels under the title of science or general science.

The science and mathematics curriculums in detail including the number of hours devoted to each of the topics, are given in this chapter in the sections dealing with the teaching of biology, chemistry, mathematics, physics, and astronomy.

Table 2.—Science and mathematics curriculum in the general 10-year school[1]

(Two figures for 1 grade in a column indicate the number of hours for each half-year)

Name of subject	Number of hours a week in grade										Total hours	
	1	2	3	4	5	6	7	8	9	10	By the week	By the year
1	2	3	4	5	6	7	8	9	10	11	12	13
Mathematics	6	6	6	6	6	6	6	6	6	6/5	59.5	2,023
Biology	----	----	----	2	2	2	3	2	1	----	12	408
Physics	----	----	----	----	----	2	3	3	4/3	4	15.5	527
Astronomy	----	----	----	----	----	----	----	----	----	1	1	34
Chemistry	----	----	----	----	----	----	2	2	2	4	10	340

GENERAL TEACHING METHODS

The classes we observed were conducted almost exclusively by the lecture-recitation method. The teacher would discuss the lesson for the day and then call upon the pupils to recite, or to work out problems at the blackboard in front of the class, or to perform a demonstration. At the conclusion of his recitation or performance, the pupil would receive a mark which would be recorded in the teacher's record book and in the pupil's notebook as well. The marking system employed throughout the U.S.S.R. is 5 for excellent, 4 for good, 3 for passing, 2 for unsatisfactory, and 1 for failing. These marks are used universally, whether for a recitation, a quiz, a final examination, or for a final course grade.

Most of the science and mathematics classes that we visited had enrollments of between 20 to 30 pupils. In no classes or laboratories were there individual seats for pupils. Rather, the pupils sat in pairs or, in some instances, three at a desk. All work, even computations and sketches, had to be done in pen and ink by the pupils. Usually written work was very neat, but sometimes, if errors were made, it was quite messy since the errors could not easily be erased. The main purpose of requiring pen

[1] Curriculum plan in effect in 50 percent of the schools in the R.S.F.S.R. in 1958–59. For the complete curriculum, see appendix I, table B.

and ink, we were told, was to inculcate on the pupils habits of neatness and accuracy in their school work.

An atmosphere of strict discipline pervaded each classroom. The authority of the teacher seemed unquestioned, and the pupils seemed to strive to make favorable impressions by answering questions and otherwise performing as the teacher wanted them to. It is our impression that the classroom demeanor and the instructional methods used were generally uniform throughout the U.S.S.R.

Formalism and rote learning characterize Soviet classroom instruction for the most part. Undoubtedly this aspect of educational practice is fostered by the prescribed uniform curriculums and the desire on the part of teachers to see that their pupils master the assigned material and be able to pass the required final examinations, the content of which are likewise prescribed by official syllabuses. Since teachers are to a considerable extent judged by the performance of their pupils in these examinations, it is only natural for them to orient their instruction and teaching methods toward this goal. Under such circumstances a favorable climate for originality and initiative evidently does not exist.

Our observation of excessive formalism in Soviet instructional methods is supported by many Soviet educators themselves. In an article prepared for *The American Mathematical Monthly*, B. V. Gnedenko, professor of mathematics at the University of Kiev, writes:[2]

> Even now there is still a serious percentage of students to whom the spirit of mathematical thinking remains alien. Frequently, such pupils even learn the contents of the course fairly well, but their knowledge in this connection remains formal, and a comparatively insignificant change in the conditions of the problem lands them in serious difficulties. . . . Moreover, I think that there is a certain amount of formalism in exposition in some textbooks as well. Thus, for example, for the first five years a pupil is occupied with arithmetic and during these years an enormous number of problems are solved. . . . As a result, the students mechanically learn these rules and their thinking is not prepared for a conscious approach to each problem.

A further example of some dissatisfaction with science instruction is given in an article, "On the State of Physics Teaching in the Russian Republic," by G. P. Evronin of Moscow in *Fizika v Shkole* (Physics in the School):[3]

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[2] B. V. Gnedenko, "Mathematical Education in the U.S.S.R.," *The American Mathematical Monthly*, Vol. 64, No. 6 (Menasha, Wis., and Buffalo, N. Y.), June-July 1957, p. 393. (Translated by J. St. Clair-Sobell and W. H. Simons.)

[3] This quotation is taken from "On the State of Physics Teaching in the Russian Republic," *Science Education*, Vol. 43, No. 3 (Albany, N. Y.), April 1959, pp. 270–274, which is a translation by I. D. London from an article by G. P. Evronin in *Fizika v Shkole* (Physics in School), 1958, Vol. 18, No. 6, pp. 43–49.

> Problem solving is of great value in the teaching of physics, but there are teachers who misuse this activity and make of it a goal in itself, as they try to run through the solutions of all problems listed in the physics exercise book. Teachers frequently pay great attention to carrying out computational operations and fail to explain the physical meaning of a problem.
>
> When it comes to problem solving, students are frequently not encouraged to go at it on their own. Frequently, all they do is copy into their notebooks what is written on the board, at times even repeating mistakes committed there.

In conclusion Mr. Evronin states:

> The weak knowledge of physics with which our students graduate should disturb everyone. In the 1958–59 school year the teachers and leadership of the schools and of the organs of popular education shall have to strive for a radical change to the better in the teaching of physics and for a rise in the level of knowledge in this subject.

Soviet educational research has for several years been seeking ways to improve teaching methods in subjects such as physics and chemistry. The recent emphasis on polytechnic education has provided certain avenues of research in this direction, and the results appear to be encouraging. In a number of experimental schools, the combining of theory with practical work and applications of theory to real situations in industry and agriculture has reinforced the knowledge learned by pupils through other methods. For example, in the teaching of physics, results of the experimental programs were that pupils solved practical problems better, developed better habits, performed more efficiently in the laboratories, acquired richer language, and possessed a firmer command of technical terms than did pupils in the regular physics classes. At the same time, teachers and pupils in the experimental schools were able to solve a number of problems relating to the polytechnic education curriculum. Although the regular students achieved somewhat higher percentages of 5 marks, they failed to perform as well in the applications of knowledge as the experimental group.

A similar experience was recorded in regard to experimental classes in chemistry, where the industrial uses and applications of chemical substances were studied in practical ways. Although the students in regular classes received higher grades, those in the experimental schools reflected higher motivation and interest, and they understood better the relationships between theoretical knowledge and industrial techniques. The same kind of result came from experimental biology classes that used much field work and actual study of plants and animals in their natural conditions,

in addition to following a prescribed schedule of inside classwork and textbook assignments.

In our talks with Soviet educators, some of them readily acknowledged that traditional methods of teaching had neglected the relations between theory and practice and that improved teaching practices were now needed and being developed. This step appears to us to be also linked to the large enrollments in Soviet secondary schools in recent years.

QUIZZES AND EXAMINATIONS

Occasionally, written quizzes covering a few problems or questions are given by the teacher to the entire class. A quiz might require a part or the whole of an academic period. Since pupils always sit at least in pairs, parallel but different sets of questions are given. Examples of quizzes given in various subjects can be found in the sections dealing with the teaching of specific subjects.

At the end of each term a written course examination is given in each subject. These examinations extend over several days in order that pupils can prepare for them. At the end of the 7th and 10th years, comprehensive written and oral examinations are given, lasting over a period of 3 to 4 weeks. The passing of these examinations makes the pupil eligible for admission to the next higher level of education. These examinations are prepared locally in accordance with State manuals, specifying the topics to be covered and the kinds of questions to be asked.[4]

TEXTBOOKS

Textbooks at all grade levels in Soviet schools are purchased by the pupils. Since they are published by the Government in great quantities at cost and are printed on low-quality paper compared to American textbook standards, they are relatively inexpensive. The authors of the textbooks are Soviet educators who have won out in competition with others. In addition to prestige, considerable financial remuneration accrues to the successful author. An interesting aspect of most Soviet science and mathematics textbooks is that there are separate books for theory and separate books for problems and exercises.

ENRICHMENT PROGRAM

The requirements that all pupils follow a prescribed curriculum

[4] For a more complete discussion on examinations see W. K. Medlin and G. Myro, *Information on Education Around the World, No. 6*, Washington, U.S. Department of Health, Education, and Welfare, Office of Education, October 1958.

does not allow them during the regular school hours to explore and develop their special interests and abilities in specific subjects. However, these natural propensities are encouraged by means of an organized program of extra-curricular activities called "circles."

Each subject-matter teacher is expected to direct a "circle" or club activity in his or her subject specialty or related specialty during after-school hours at the school or Pioneer organization. For this work the teachers are paid hourly wages which are in addition to their regular salaries. Also, pupils may pursue their bents in the Pioneer Houses or Palaces which have been established to foster cultural, scientific, and physical activities of Communist youth. Trained leaders and teachers are employed in the Pioneer Palaces to direct the various programs which are conducted during after-school hours, evenings, and Sundays.

"Circles" in science and mathematics include such clubs as radio, aviation, chemistry, gardening, and mathematics. In School Number 204 in Moscow, for example, we were told the "chemistry circle" was working on special projects in qualitative and quantitative analysis. In another school we saw posted on the bulletin board in front of a mathematics class some difficult theorems and problems which were solved by members of the "mathematics circle."

A program which has done much in stimulating pupil interest in mathematics is that of the school Mathematical Olympiads. This activity was begun in 1934 by the University of Leningrad and has subsequently spread throughout the Soviet Union and, in some degree, to other countries. These Olympiads are written contests in the solution of problems that are more difficult than those ordinarily given in schools. These contests are held annually in most of the larger cities, and prizes and other suitable recognition, such as certificates, are given to the winners. The Olympiads assist to a considerable extent in the identification of mathematical talent. Many of the present outstanding Soviet mathematicians and professors in higher educational institutions are former Olympiad winners.[5]

A newly developed program is now underway, designed to stimulate interest in mathematics and to cover theory and problems over and above that given in the regular curriculum. Dr. A. N. Kolmogorov, an outstanding mathematician and a member of the U.S.S.R. Academy of Science, has urged that special classes

[5] An account of these Olympiads and some of the sample problems given in them appears in the article by B. V. Gnedenko, referred to in an earlier footnote of this chapter.

be organized after regular school hours. These classes are to meet one or two times a week over a period of 3 years. A program of this type, organized by interested teachers of the Pedagogical Institute and schools in the city of Ivanovo, a textile center, is now in operation. We were told by responsible Soviet educators that the University of Moscow will adopt this idea, and other institutions are likewise expected to do so. It is also hoped that this kind of program will spread to other disciplines.

Special schools for pupils gifted in dancing, music, and dramatics have existed for a long time in the Soviet Union and are well known. There apparently has been some consideration given to the establishment of schools for children who show special aptitudes for the sciences.[6] But in our talks with Soviet educators there was no evidence that there are immediate plans for them.

LABORATORIES, EQUIPMENT, AND FACILITIES

For the most part the science laboratories we saw had a dual function. They were used on some days as lecture rooms for theory purposes and on other days for laboratory work. Each desk, which was occupied by two or three students, was provided with electrical and gas outlets. In rural areas, spirit lamps were used rather than bunsen burners.

In advance of the meeting of the laboratory class, which always runs consecutively for two academic periods of 45 minutes each whereas lecture classes generally meet for one period at a time, the equipment would be placed on each pupil's desk by the teacher and the assistant. Almost every science teacher had an assistant whose duty was to assist with laboratory instruction and the care of equipment. The assistant would usually be a person who is planning to become a full-fledged teacher and who is currently enrolled in a pedagogical institute in evening study or by correspondence.

We asked Soviet educators about their seeming preference for the method of combination lecture-laboratory rooms as compared to the common practice in schools in the United States, in which pupils set up their own equipment in separate laboratory rooms. We were told that actually they prefer the separate classroom and the separate laboratory, but due to the shortage of school buildings brought about by war devastation and expanding enrollments, separate laboratory rooms were out of the question, generally speaking, at the present time.

[6] Nikolai Nazarov, "Schooling for Future Scientists," *U.S.S.R.*, Jan. 1959, No. 1 (28), Embassy of the Union of Soviet Socialist Republics in the U.S.A., p. 37.

Adjoining each lecture-laboratory room was a preparation and stock room for the teacher and the assistant. At the schools we visited these rooms seemed to be amply stocked with the equipment and materials needed by the pupils. For example, there would be approximately 25 bottles of the reagent to be used, or a similar number of microscopes or voltmeters. Thus, each pupil in the class would be provided with the necessary equipment and materials to perform experiments, a number of which we observed. We did notice, however, that in the chemistry laboratories none of the students wore protective rubber aprons.

There also appeared to be available an ample supply of audio-visual aids—charts, models, specimens, projectors, etc. In some of the schools some pupils were trained to be projectionists. Almost every science room had pertinent wall charts hung on the walls and specimens and models on display in cabinets. In slide rule instruction, which is part of the curriculum in the regular 10-year school, each pupil is loaned a school-owned slide rule on which to learn and practice.

Although it seemed to us that in the schools we visited the facilities and equipment were generally adequate for effective science and mathematics instruction, apparently this situation is not true in all the schools of the Soviet Union. The article by G. P. Evronin previously referred to in the section on general teaching methods states:[7]

> The proper organization of physics teaching is rendered difficult in schools not having physics rooms. Altogether 19 percent of the schools in the Russian Republic are like that.
>
> In many schools, including those having separate physics rooms, the maintenance of apparatus is not satisfactorily handled, for example, in School No. 2 in Prokop'evsk (Director A. P. Kobzeva) . . . . . and in School No. 4 of Kemerovo (Director E. G. Ginzburg).
>
> In these schools pieces of apparatus in good repair are not, as a rule, separated from those out of commission; on the same shelf all kinds of devices are mixed up.

The Teaching of Biology

Like other subjects in the Soviet school curriculum, biology serves as a means of general education by acquainting pupils with the facts of the biological world in which they live. Also, the course in biology should provide a certain amount of technical training. The aims of the course are as follows:[8]

[7] G. P. Evronin, *op. cit.*, p. 278.

[8] *Programmy srednei shkoly. Biologiia.* (Syllabi for secondary school. Biology.) Moscow, Uchpedgiz, 1958. Pp. 1 ff.

Figure 2-2.—Fifth grade biology pupils.

To give systematic, basic knowledge of the biological sciences.
To help in forming in pupils a materialistic outlook.
To reveal the harm of superstition and prejudice.
To acquaint pupils with the achievements of Soviet science in agrarian production.
To inculcate on the pupils practical knowledge by work in school laboratories, collective farms, and motor tractor stations.

The course of biology in the secondary school includes the following subjects: Botany, zoology, anatomy and physiology of man, and principles of Darwinism.

BOTANY

In the course in botany the pupils are taught the fundamentals of plant life and development. In grade 5 they study the structure and life of plants. They learn about seeds and sowing, growth of seeds, roots, nutrition of plants from the soil, and the formation of organic matter. They are taught the function of green leaves and the interrelation between green plants and living animal organisms. The fertilization and reproduction of plants are explained in an elementary way.

In a fifth grade class in biology the teacher, a graduate of a 2-year teacher training institution and currently enrolled in a third year program of teacher education by correspondence study, was explaining, by means of charts, the parts and composition

of blossoms and leaves. Flowers were distributed among the children, and they were asked to identify the parts and their functions. Pollinization was explained in the textbook and by the teacher.

In the sixth grade the botany course begins with a review of the work of the fifth grade. They then study such useful plants as potatoes, cabbages, wheat, corn, and flax. Each of these plants is analyzed from the point of morphology, and techniques of cultivating them are stressed. In studying potatoes and cabbages, pupils are taught the square planting method as well as methods of planting seedlings. The growth and reproduction of trees, particularly apple trees, are also studied in this grade.

In studying the characteristics and growing of wheat, pupils receive an elementary picture of various periods of plant growth in the light of the Lysenko theory. The pupils are asked to demonstrate vernalization in plants in the school plot or in the domestic environment. They study the peculiarities of corn and its importance to the national economy. They learn how the growth of corn has been made possible in the northern area of the U.S.S.R. The problem of mechanizing large-scale agricultural production is taken up. Excursions, slides, and movies are used to acquaint pupils with these processes.

On the development of new types of plants, the theory of I. V. Michurin is studied. According to the Soviet syllabus for this

Figure 2-3.—Sixth grade biology class, Leningrad.

grade, Michurin scientifically proved the possibility of remaking the nature of plants.

The school plot is widely used as a means of teaching practical knowledge of botany. Every school we visited had a school plot where plants and fruit trees were grown. During the growing season while school is in session, the pupils are required to spend several hours a week in labor work in the plot. During the summer months pupils are given definite assigned periods in which they are responsible for the care of the plot. Profits from the produce of the school plot are used in various ways for the benefit of the school and the pupils.

ZOOLOGY

The course in zoology (grade 7) gives an elementary picture of the historical evolution of the animal world. The pupils are taught how coordination of all the organs in animals is achieved by means of the nervous system. The teaching of Michurin and Pavlov are introduced in an elementary way. The study of animal life begins with the simplest forms and procedes to the complex ones. The great variation in the forms of life and their adaptability to the conditions of their environment are stressed.

The course commences with a study of one-celled animals, followed by hydra, worms, and mollusks. Insects are studied next. Besides learning about the structure and behaviour of insects, pupils learn about those which are harmful to agriculture and which are disseminators of disease, as well as those which are useful to mankind, such as bees.

Fish are studied next. Three or four samples of fish from fresh and salt water are studied according to the species selected by the teacher. In studying the various kinds of fish the pupils are taught how to safeguard and improve the fisheries in the U.S.S.R.

Although amphibians have little connection with the national economy, they are studied because of their great importance in the understanding of the animal world. The study of reptiles reveals the life of the vertebrae.

The unit on birds includes a broad range of material. For example, in the study of doves and other birds with which the pupils are acquainted, the likeness in the embryo stage to reptiles is pointed out. In the study of domestic birds, such as geese, ducks, and turkeys, the biological relationship of them to their wild ancestors is analyzed.

The unit on mammals discusses the characteristics of this most

highly developed form of animal. The pupils study the brain structure and reproduction of various kinds of mammals.

The course in zoology concludes with a picture of the historical evolution of the animal world and the influence of environment on the changing conditions of life on the earth. The problem of the origin of man is also treated briefly.

We visited a seventh grade class in zoology at a rural school south of Moscow. The lesson was on the comparative anatomies of man and monkey. A chart showing the anatomies of the two was on a stand in front of the classroom. The woman teacher lectured for awhile and then called upon several pupils to recite. We noted that the room seemed well provided with plants, charts, models, specimens, and other visual aids.

ANATOMY AND PHYSIOLOGY OF MAN

The course in anatomy and physiology of man is taught in grade 8. The purpose is to give pupils a knowledge of the human organism and basic information which will help to safeguard and strengthen health. In the process of this study the pupils become acquainted with the work of some of the Russian scientists. The contribution of the eminent scientist, Pavlov, is especially noted.

The first unit is on the bone and muscular system, followed by one on the organs of circulation and the influence of the nervous system on the heart and on the blood vessels. The next theme is organs of respiration. Here are also taken up problems of hygiene and ways of preventing disease carried through the air. Information on tuberculosis and its prevention is given.

The next topics treated are organs of digestion and metabolism. The importance of vitamins A, B, C, and D is stressed. In the study of the nervous system the pupils are informed about its structure and the roles of labor and rest in producing well-being and health.

While learning anatomy and physiology, pupils are required to dissect animal organs and study them by means of microscopes. They must know the bones of the skeleton and be able to point them out on their own bodies. They are also expected to know the functions and location of the lungs, heart, stomach, liver, and appendix and be able to take the pulse.

PRINCIPLES OF DARWINISM

This subject, which is given in grade 9, teaches about the origin of life together with the history of evolution in the organic

world, including the problem of the origin of man. The concept of evolution is the main theme of the course.

The first unit deals with organisms and their environments. The diversity of organisms and their adaptibility to environmental conditions is explained. This is followed by a section purporting to give proof of evolution. A comparison is made between the teachings of Darwin and the French naturalist J. Lamarque.

The third unit is divided into the following: Inheritance and variability; variations in cultivated plants and domestic animals; artificial selection; and the origin of species. Michurin's theory is included in the presentation of the evolutionary theory by Darwin. Also, attention is paid to the research work in hybridization by N. V. Tsitsina and the American naturalist Luther Burbank. The theoretical study is expected to be closely related to practice in plant growing and animal breeding.

The concluding theme of the course deals with the origin and evolution of life on earth. Engels' theory is treated, followed by an explanation of the hypothesis of A. P. Oparin, which treats the problem of the origin of life from a materialistic point of view. The origin of man is the final topic taken up.

Great importance is attached to the organization of naturalist work in the schools. It is the duty of the teacher to inculcate on pupils an understanding of, and love for, plants and animals, to awaken interest in the study of them and in the safeguarding of the natural resources and wealth of their native land.

METHODS USED TO STRENGTHEN KNOWLEDGE OF BIOLOGY

Mention has already been made of the new emphasis on polytechnic training in the schools of the Soviet Union, and the use of school plots to provide an opportunity for pupils to perform manual labor and also to gain practical first-hand knowledge with growing things.

In rural areas, where there is naturally strong emphasis on agriculture, excellent opportunities are available to develop projects which increase the knowledge and understanding of biological sciences. At the rural 11-year school in Gorki-Leninskie, near Moscow, this program has been well planned. At a short distance from the school there is an Institute of Genetics, a component of the Academy of Agricultural Sciences. Arrangements have been made whereby the school and its pupils assist the research workers of the Institute.

In the fourth grade pupils grow vegetables in the school plot, and in the fifth grade they grow soft and hard fruits as well. In

the sixth and seventh grades they grow corn for the Institute in a 6-acre plot. As well as tending the plot during the growing season when school is in regular session, the pupils work in shifts during the summer months for 18 days, 4 hours a day.

In the eighth grade the pupils receive theoretical instruction in plant growing. During the following summer they work in the fields of a nearby collective farm where 25 acres of land are reserved for their use. In addition, in May while they are still in the eighth grade and in September and October while they are in the ninth grade, they work 2 full days a week at this farm. During this period they grow barley, corn, cabbage, potatoes, and carrots.

In the ninth grade the pupils receive theoretical instruction in animal husbandry. In conjunction with this study there is practical study at a nearby livestock farm attached to the Institute of Genetics. The pattern of practical instruction with livestock is similar to that employed in the study of crops, the pupils completing this work in the fall during their 10th year. In the 10th and 11th years, since this is an experimental 11-year school, the pupils study the electrification and mechanization of agriculture. As well as learning how to operate tractors and combines, the pupils also learn about the care and repair of these machines, and they are required to give practical demonstrations of their knowledge.

At a city school in Moscow which we visited, a nature-study room is assigned to the seventh grade as a special project. In this room were an aquarium, birds, and such animals as rabbits, guinea pigs, and mice. The seventh grade pupils were divided into groups of 5 pupils who, in rotation, had responsibility for feeding and taking care of them. In this school and several other schools visited, pupils were required to water and look after the plants which were present everywhere.

At several of the schools children were working at projects involving the breeding and raising of rabbits. They built the cages and fences, fed the rabbits and took part in selling them. The money earned was used to defray the cost of various school activities, such as excursion trips.

BIOLOGY CURRICULUM

Following is a topical outline of the official curriculum with hours of instruction for biology taught in grades 5 through 9 in the regular 10-year school:[9]

[9] *Ibid.*, pp. 27 ff.

Figure 2-4.—"Socially useful work" at rural school. Building a rabbit pen.

Biology Curriculum, 10-Year School, Grades 5 to 9

BOTANY

Grade 5 (66 hrs.)

Introduction (1 hr.)

I. Plants in nature and in agricultural economy (4 hrs.)

II. Cellular structure of plants (3 hrs.)

III. Seed and sowing. Growing of seeds (14 hrs.)
Practical works and demonstration
Excursions

IV. Roots. Nutrition of plants from soil (10 hrs.)
Practical work and demonstration

V. Leaves. Formation in plants of organic substance (8 hrs.)
Practical work and demonstration

VI. Stems. Movement and deposition of substances in plants (9 hrs.)
Practical work and demonstration

VII. Reproduction of plants (14 hrs.)
Practical work and demonstration
Excursions

VIII. Plants. Live organisms (3 hrs.)
(Respiration, nutrition, growth, and reproduction)

Grade 6 (66 hrs.)

Review of the results of summer work (2 hrs.)

I. Cultivation of plants (9 hrs.)

II. Particular plants and their cultivation (21 hrs.)
   a. Potato (4 hrs.)
      Practical work and demonstration
   b. Cabbage (3 hrs.)
      Practical work and demonstration
   c. Wheat (4 hrs.)
      Practical work and demonstration
   d. Corn (4 hrs.)
      Practical work and demonstration
   e. Flax (2 hrs.)
      Practical work and demonstration
   f. Apple trees (4 hrs.)

III. Ripening of fruit (5 hrs.)
   Demonstration

IV. The basic group of plants (26 hrs.)
   a. Bacteria (4 hrs.)
   b. Algae (3 hrs.)
   c. Mushrooms (4 hrs.)
   d. Lichen (1 hr.)
   e. Moss (2 hrs.)
   f. Fern type of plants (3 hrs.)
   g. Gymnospermous plants (3 hrs.)
   h. Angiospermous plants. (6 hrs.)

The study of these plants should be supported by demonstration, practical work, and necessary excursions in the spring, and visiting hothouses. The excursions are carried out during special allocated hours during the week.

V. General Picture of Evolution of Plants on Earth (3 hrs.)

ZOOLOGY

Grade 7 (99 hrs.)

The review of summer experiences (2 hrs.)

Introduction (1 hr.)

I. Simple animals (4 hrs.)

II. Coelenterata (intestinal) (3 hrs.)

III. Worms (6 hrs.)

IV. Mollusks (3 hrs.)

V. Arthropoda (16 hrs.)

VI. Vertebrates (47 hrs.)
   a. Fish (8 hrs.)
   b. Amphibians (5 hrs.)
   c. Reptiles (4 hrs.)
   d. Birds (15 hrs.)
   e. Mammals (15 hrs.)

This work must be supported by laboratory work, demonstrations, and excursions.

VII. Mammals in practical use in husbandry (11 hrs.)

VIII. Review (6 hrs.)

Anatomy and Physiology of Man

Grade 8 (66 hrs.)

Introduction (1 hr.)

I. General view of structure and functions of organisms (6 hrs.)

II. Bone and muscular system (7 hrs.)

III. Blood vessels and circulation of blood (9 hrs.)

IV. Organs of respiration (5 hrs.)

V. Digestive organs (8 hrs.)

VI. Metabolism (7 hrs.)

VII. Skin (3 hrs.)

VIII. Nervous system (17 hrs.)

IX. Development of organisms (2 hrs.)

Review (1 hr.)

Principles of Darwinism

Grade 9 (34 hrs.)

Introduction (1 hr.)

I. Organisms and environment
   a. Variations in organisms and their adaptability to conditions in their environments (1 hr.)
   b. Interrelation between organisms and conditions of environment (3 hrs.)

II. Evolutionary teaching of Darwin
   a. Development of historical outlook of nature (3 hrs.)
   b. The proof of evolution (3 hrs.)
   c. Inheritance and mutations (2 hrs.)
   d. Mutations of cultivated plants and domestic animals. Artificial selection (2 hrs.)
   e. Origin of species by way of natural selection (4 hrs.)

III. Michurin's teaching
   a. Heredity of organisms (4 hrs.)
   b. Theory of development of organisms by stages (1 hr.)
   c. Application of Michurin theory to husbandry (2 hrs.)

IV. Origin and evolution of life on earth
   a. Origin of life. Development of plant and animal life (3 hrs.)
   b. Origin of man (4 hrs.)

Review (1 hr.)

The Teaching of Chemistry

The aim of the chemistry program in the secondary school is to acquaint pupils with simple and systematic principles of chemistry; have them acquire chemical facts in accordance with the leading theories; develop in them the ability to observe and explain chemical phenomena which operate in nature and industry; and teach them habits of dealing with substances, chemical ware, and other laboratory apparatus.[10] According to the Soviet view, instruction in chemistry fosters a scientific, atheistic world view and educates in the spirit of Soviet patriotism.

Systematic study of chemistry, providing polytechnic instruction for future vocational applications, begins with grade 7 and continues through grade 10. The importance of chemistry to the national economy of the U.S.S.R. is stressed throughout the program, and in line with this objective at least one excursion must be conducted each year to a plant employing chemical processes.

GRADE 7

In this beginning course pupils become familiar with oxygen, hydrogen, air, water, oxidation, acids, bases, and salts. The teacher's explanation is usually followed by demonstrations and independent work in the laboratory. Theoretical information is given at such level that pupils can understand substances and their chemical transformations. They receive elementary information about types of chemical reactions, about atoms and molecules, and about the law of conservation of matter. They are expected to be able to read formulas and equations of reactions, use valence, write equations involving simple chemical reactions, and calculate the weight-relationships in these reactions.

The pupils become acquainted in this grade with the contributions of M. V. Lomonsov to the field of chemistry. They are expected to acquire the following knowledge and skills:

1. How to handle chemical substances, such as acids and alkalis. How to use test tubes, burners, retorts, and other kinds of laboratory equipment.
2. How to use weights and how to measure volumes of liquids.
3. How to dissolve chemical substances. How to filter, collect gases, and wash equipment.
4. How to identify oxygen, hydrogen, acids, and bases.
5. How to record observations and make drawings.

[10] R.S.F.S.R. Ministry of Education. *Programmy srednei shkoly. Khimiia.* (Syllabi for secondary school, Chemistry.) Moscow, Uchpedgiz, 1958. 24 p.

In a seventh grade chemistry class that we observed in session, the lesson was on the exchange of salts. The teacher placed on the board, one at a time, the chemical substances listed below. A pupil was called to the board and asked to write an equation of each reaction, showing the proper number of ions involved and the precipitate.

Exercise 1. Barium chloride and potassium sulfate.

Exercise 2. Lead nitrate and sodium chloride.

Exercise 3. Barium chloride and sulphuric acid.

GRADE 8

In the eighth grade, pupils review the theoretical material of the seventh grade and at the same time learn more about reactions and exchanges between acids, bases, and salts with the aid of concepts of the gram-atom and the gram-molecule. The three principal themes are: Alkali metals; halogens; oxygen and sulfur. All these themes have significance in training the pupils in the mastery of the periodic system of elements by D. I. Mendeleev.

In the eighth grade chemistry the pupils are expected to learn how to do the following:

1. To select the proper apparatus for a given problem.
2. To be able to purify chemical substances.
3. To be able to test for and recognize sulfuric acid, hydrochloric acid, and their salts.
4. To be able to produce desired chemical products, either directly or through intermediate steps.

GRADE 9

The chemistry in this grade commences with a systematic study of the periodic table of chemical elements and the structure of matter.

In the process of studying nitrogen and phosphorus the pupils become acquainted with ammonia, nitric acid, and nitrogenous and phosphate fertilizers, etc. In the study of carbon and silicon they learn about solid fuels and their derivatives and about industries processing materials containing silicon. As a result of instruction in these grades, pupils are expected to be able to do the following:

1. To be able to identify well-known compounds such as ammonia, nitric acid, and carbonic acid.
2. To identify and understand fertilizers.

3. To conduct simple chemical experiments involving the elements studied in this grade.

At a 10-year school in the Georgian S.S.R., we observed a ninth-grade class consisting of about 25 pupils. The members of the class first performed an experiment of producing ammonia gas by placing a piece of calcite in a solution of ammonium chloride. In addition to the pupils performing the experiment at their desks, one pupil performed the experiment in front of the class. The pupils were asked to identify the gas produced by its odor. Then the pupil giving the demonstration in front of the class was asked to write a properly balanced equation of the chemical reaction on a small portable blackboard as there were no permanent wall blackboards in this classroom. This chemistry classroom was less well equipped than some of the chemistry classrooms in urban areas we visited. Spirit lamps were used instead of bunsen burners. A small demonstration table and a periodic wall chart were the only evidences that this was a chemistry room.

After the experiment had been performed and the chemical equation checked out, the remainder of the period was spent in balancing equations of other chemical reactions. The teacher gave the reacting substances, and a pupil was called to the front of the room to write a balanced equation. The teacher would assist when necessary and also call upon other pupils for help. Pupils at desks wrote down in their notebooks the steps as they were completed. The teacher of the class was a middle-aged woman who wore a white smock and who was a graduate of Tbilisi State University. She had a woman assistant who was in training to be a teacher.

GRADE 10

The program in the 10th grade consists of a study of metals, Avagadro's Law and its applications, and organic substances. The pupils are taught the physical and chemical properties of various metals and alloys. The alkali metals, alkaline-earth metals, aluminum, and iron are studied.

In the unit on organic matters the pupils learn about the hydrocarbons and other basic organic compounds. Comparisons are made between organic and inorganic substances. Fundamental to the study of organic chemistry is the theory of A. M. Butlerov. A new topic being introduced in the 1950–60 academic year is synthetic high-molecular compounds to which 10 periods will be devoted.

We visited a 10th grade chemistry class at an experimental school in Moscow. This class of about 25 pupils, of whom only 5 were boys, was reviewing for its final examination in chemistry. Pupils were required to go to the front of the class and write chemical substances in ionic form, showing the proper valences. They were then asked to combine substances and write a balanced equation, indicating the precipitates, if any. One of the examples worked out during the class was the reaction of aluminum sulfate and barium nitrate. Pupils were also required to explain the basis for arrangement of chemical elements. On the walls around the room were charts showing the industrial uses of various chemical compounds. The teacher of this class was a young woman who apparently knew her subject and appeared to be an effective teacher.

SOME EXAMPLES OF QUIZZES IN CHEMISTRY

During our visits to schools we obtained samples of quizzes which had been given during the year. Following are some of the quizzes which were given and which serve to show the level of work required in various grades:

A Seventh-Grade Quiz (Given in April 1959)

1. What do we call a salt? Give definition, write the formulas of three salts, and name them.
2. Determine the percentage of copper and oxygen in cupric oxide.
3. What is a gram-atom? How many gram-atoms of oxygen are contained in a gram-molecule of carbon dioxide?
4. How many grams of hydrogen are produced by the action of sulfuric acid on 0.5 grams of zinc?

An Eighth Grade Quiz (Variation No. 5)

1. Which reactions are classed as exothermic and which endothermic? Give an example of each type of reaction.
2. Write the following formulas:
   a. Zinc sulfide
   b. Zinc sulfite
   c. Zinc sulfate
3. What regent is used to test for sulfuric acid and its salts?
4. State the rule for dissolving sulfuric acid in water.
5. What weight of phosphorus will be necessary in order to obtain 142 grams of phosphorus anhydride. The atomic weight of phosphorus is 31.

A Ninth Grade Quiz (Given in January 1959)

1. Judging from the location of chromium in the Mendeleev periodic table, write the formula of chromic anhydride and of chromic acid.

2. What is the difference between short periods and long periods, and on what principle is each long period subdivided into rows in the Mendeleev periodic table?
3. Write the equation for the reaction between the following substances:
   a. Cesium oxide and hydrobromic acid.
   b. Strontium hydroxide and nitrous acid,
   c. Hydrogen sulfide and calcium hydroxide.
4. In the Mendeleev periodic system what place is occupied by arsenic? Describe the properties of arsenic. Is it metallic or nonmetallic, and how does it combine with oxygen and hydrogen?

A Ninth Grade Quiz (Given in April 1959)

1. Ammonia was passed through 200 grams of a 10 percent solution of nitric acid. What salt and how much of it was formed in the solution if the amount of ammonia used is assumed to be in excess?
2. How is ammonia converted to ammonium sulfate?
3. Briefly describe the properties of ammonium hydroxide. Write an equation to illustrate each chemical property listed, and in each case state the conditions under which the reaction will occur.
4. Write complete abridged, ionic equations for reactions between the following reagents:
   a. Calcium hydroxide and nitric acid,
   b. Ammonium nitrate and caustic soda.

A 10 Grade Quiz (Given in March 1959. Time allowed—45 minutes)

1. Write equations for a series of reactions by which methyl formate would be prepared, beginning with methane.
2. Describe the characteristic reactions of glucose.
3. How would you prepare barium sulfate by an exchange reaction? Calculate the necessary weights of the initial compounds for the preparation of 4.66 grams of barium sulfate.
4. Which reactions are called hydrolysis?

CHEMISTRY CURRICULUM

Following is a topical outline of the official curriculum with hours of instruction for chemistry which is taught in grades 7 through 10 in the regular 10-year school:[11]

Chemistry Curriculum, 10-Year School, Grades 7 to 10

Grade 7 (66 hrs.)

1. Substances and their transmutations (8 hrs.)
2. Atoms, chemical elements. Principles and laws of chemistry (14 hrs.)
3. Oxygen. Air. Combustion (8 hrs.)
4. Hydrogen. Water. Valence (15 hrs.)

[11] *Ibid.*, pp. 13 ff.

5. Oxidation, acids, bases, and salts (21 hrs.)
6. Excursions: water-purification station, oxygen plant, mechanical shop, calcining furnace, etc.

Grade 8 (66 hrs.)

Review of seventh grade material (21 hrs., of which 4 are for practical work): (1) interaction of acids, bases, and salts among themselves, and (2) experimental problems on oxidation, acids, bases, and salts.

1. Alkali metals (sodium and potassium) (4 hrs.)
2. Halogens (18 hrs., of which 4 are for practical work)
3. Oxygen and sulfur (23 hrs., of which 3 are for practical work)

Grade 9 (99 hrs.)

Review of eighth grade work (6 hrs.) [12]

1. Periodic law and periodic table of chemical elements of D. I. Mendeleev. Structure of matter (26 hrs.)
2. Nitrogen and phosphorus (40 hrs., of which 9 for practical work)
3. Carbon and silicon [13] (27 hrs., of which 4 for practical work)

Grade 10 (136 hrs.)

1. Metals (40 hrs.)
   General properties of metals (6 hrs.)
   Alkali metals (4 hrs.)
   Alkaline-earth metals (6 hrs.)
   Aluminum (6 hrs.)
   Iron (10 hrs.)
   Practical exercises (8 hrs.)
2. Avogadro's Law and its application in chemistry (6 hrs.)
3. Organic substances (54 hrs.)
   Basic data on organic and inorganic substances (2 hrs.)
   Hydrocarbons (18 hrs.)
   Oxygen-containing organic compounds (18 hrs.)
   Nitrogen-containing organic compounds (6 hrs.)
   Practical exercises (10 hrs.)
4. Preparation for examination (16 hrs.) [14]

The Teaching of Mathematics

The purpose of mathematics instruction in the Soviet general school is to impart to pupils a definite body of knowledge useful for understanding numerical relations of simple situations in the

[12] Schools operating on new 1958-59 curriculum are not obliged to do the review.
[13] Schools on new curriculum will offer this in grade 10, devoting 20 hours less to its study.
[14] Sixteen hours are devoted for review and preparation for the final examination.

real world and for investigating spatial forms.[15] This knowledge should give to pupils a clear impression of mathematics as a systematic discipline and thus prepare them to study more advanced mathematical topics and related subjects. In the process of studying mathematics, pupils are expected to test their knowledge and prove results through application of methods of scientific proof and control. Some Soviet mathematics educators suggest that pupils should develop skill in organizing and conducting simple mathematical research. The study of mathematics should also assist in developing grammatical competence and precision and brevity of expression.

Included in the body of knowledge deemed to be of general value are the following concepts, skills, and abilities:

1. An ability to carry out arithmetic operations with whole numbers and fractions.
2. A familiarity with systems of measurement.
3. A familiarity with simple geometric forms.
4. A familiarity with various methods of visual representation of quantitative relationships (graphs, diagrams, etc.).

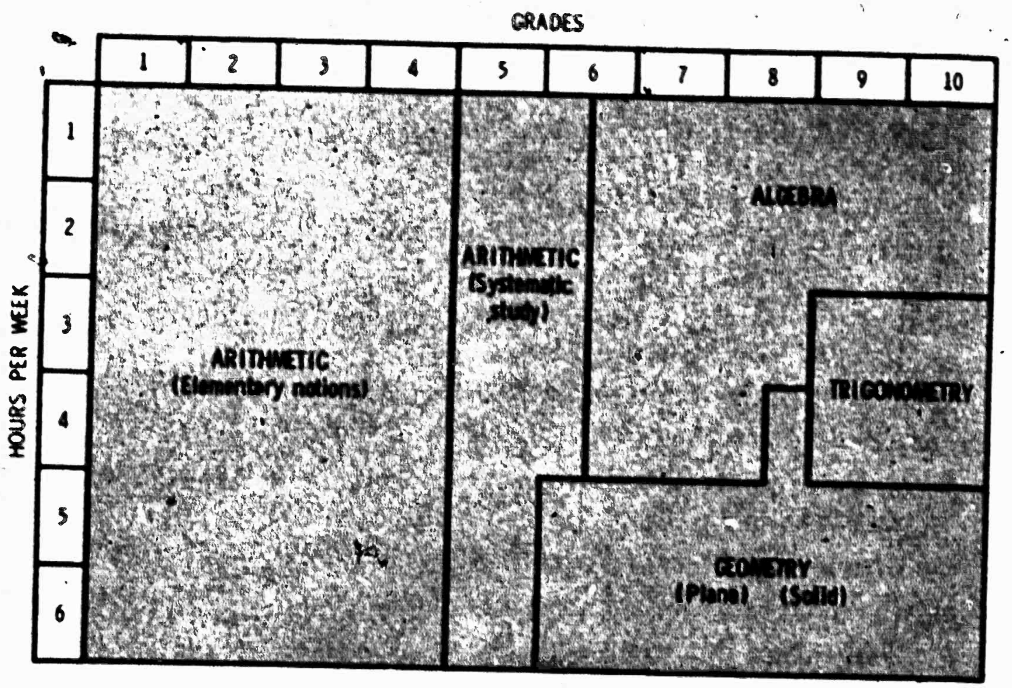
POLYTECHNIC EMPHASIS

The recent Soviet emphasis in polytechnic education has resulted in increased efforts in relating mathematics to problems connected with practical life and fundamentals of production. To achieve this goal, mathematics teachers in recent years have been urged to emphasize topics which contribute to a better understanding of polytechnic education. Specific mathematical topics considered to be of polytechnic value include:

1. Approximate computation
2. The use of simple calculating machines and devices
3. The construction and use of tables
4. Functions and graphs
5. Approximate and graphical solution of problems
6. Field measurements
7. Drawing and the use of drawing instruments
8. Accuracy and precision
9. Rounding off of numbers
10. Measurement of inaccessible distances

[15] In preparing this section use has been made of some materials contained in the doctoral thesis, *The Mathematics Program of the Soviet Secondary School: Its Status and Innovations*, submitted by Bruce R. Vogeli to the University of Michigan in 1959, 547 pp. For an extended treatment of mathematics taught in the Soviet Union, see Vogeli's thesis.

Mathematics curriculum in the 10-year school



According to the official mathematics syllabus for the academic year 1957–58, teachers of mathematics are expected to give particular attention to the understanding of fundamental ideas, especially the concept of a function and its graphical description.[16] The study of simple functions and their graphical interpretations begins as early as the fifth grade. The historical development and cultural value of mathematics are to be taught, and the contributions of such outstanding mathematicians as Euclid, Archimedes, Descartes, Euler, Gauss, and Lobachevskii are to be noted.

PARALLEL PRESENTATION OF SUBJECT MATTER

Reference has already been made to the Soviet practice of teaching a number of related subjects in the same grade with the aim that such presentation will contribute to a better understanding of the interrelationships between them. In mathematics, this approach is achieved by teaching arithmetic and geometry in the first half of the 6th grade and algebra and geometry in the last half of this grade; algebra and geometry in the 7th and 8th grades; and algebra, geometry and trigonometry in the 9th and 10th grades. The parallel treatment of mathematics subjects is illustrated graphically in the chart above.

[16] *Programmy srednei shkoly na 1957–58 uchebnyi god. Matematika.* (Syllabi for secondary school for the 1957–58 school year. Mathematics.) Moscow, Uchpedgiz, 1957. 44 p.

ARITHMETIC

In grades 1 through 4 pupils study the elementary notions of the arithmetic of numbers, and they develop skills in simple calculations and measurements. In grade 1 they are taught numeration and simple arithmetic operations with whole numbers. In grades 2 and 3 they build upon and extend these concepts. In grade 4 they are taught composite denominate numbers and simple fractions. They also learn addition and subtraction on the abacus, which is used extensively throughout the U.S.S.R. in commercial establishments in lieu of adding machines. Practice on the abacus strengthens pupils' understanding of number concepts.

In the fifth grade and the first half of the sixth grade pupils complete the study of arithmetic. They learn about combined operations, divisibility of numbers, operations with fractions, decimals, percent, ratios, and proportion. The study of decimals follows that of fractions, and the fact that decimals are special kinds of fractions is pointed out.

In the fifth grade 6 hours of practical work are required. This practical instruction includes such tasks as:

1. The marking of points and the laying out of lines in the field.
2. Measurement of distances in the field with measuring tapes, field compasses, and by paces.
3. Visual estimation of distance.
4. Use of the cross staff.
5. The laying out of a rectangular plot and the calculation of its area.
6. The calculation of the area of plots of land having the form of quadrilaterals.

At a school in Kiev we observed a fifth grade class of about 20 pupils performing measurements on the school playground under the supervision of their teacher.

In our visit to a boarding school in Moscow, we sat in on a fifth grade arithmetic class. The following three exercises consumed most of the 45-minute period:

Exercise 1. Find x if $0.7x = 17.5$

Exercise 2. Find the value of $4\frac{1}{2} \times [8\frac{3}{5} \times \frac{7}{4} - (2\frac{61}{90} - 1\frac{1}{12})]$

Exercise 3. Find the value of

$$\left[\frac{(1.25 \div 3.75 + 4\frac{4}{5} \div 3\frac{1}{3}) \div 1\frac{1}{5}}{\frac{5}{18} + \frac{1}{15} - 0.35}\right] \div 13.5$$

Pupils were called to the front blackboard to work out each exercise. In case of exercises 2 and 3, the pupil who commenced

the problem was replaced in turn by other pupils who continued the solution of the problem from the point at which the previous pupil stopped. Systematic, step-by-step solution of the problem, involving working out component parts and substituting their values, was strongly emphasized. Pupils at their seats were required simultaneously to work out these same exercises in their notebooks. The teacher of this class was a man with 7 years of teaching experience. He had graduated from a 2-year pedagogical school, majoring in physics, and was presently enrolled as a 5th-year student in a pedagogical institute and majoring in mathematics.

In a fifth grade arithmetic class in Zagorsk, we observed arithmetic exercises being worked in class similar to that just discussed. In one of the pupil's notebooks, under the date of February 18, 1959, we noted the following two problems with their solutions:

Find the unknown quantity:

Exercise 1. $9\frac{5}{12} + x = 12\frac{7}{8}$

Exercise 2. $\frac{5}{18} - x = \frac{7}{30}$

ALGEBRA

The purpose of algebra is to teach the pupils how to generalize the processes of arithmetic, how to solve algebraic equations with ease and understanding, and how to apply this knowledge in solving problems in allied disciplines such as chemistry and physics.

The teaching of algebra begins in the second semester of grade 6 and continues through grade 10. Topics covered during the study of algebra include solution of equations of first, second, and higher degree; systems of simultaneous equations; factorization of polynomials; roots and powers; limits and progressions; exponents and logarithms; permutations and combinations; complex numbers; and inequalities. The theory and use of the slide rule is taught in grade 9.

At an eighth grade class in algebra in Moscow, the following problems were assigned to the pupils for homework:

Exercise 1.—A bus left City A for City B, which are 150 kilometers apart. Three hours after the bus left City A, it had to stop for 20 minutes. During the remainder of the trip the bus went 6 kilometers per hour faster than it did during the first 3 hours, and it thereby arrived at City B at the same time it would have if it traveled all the way at its initial speed without stopping. Find the initial speed of the bus.

Exercise 2. Solve each of the following systems of equations:

$$\begin{cases} \dfrac{x^2+xy+y^2}{xy}=\dfrac{7}{2} \\ x-6+y=0 \end{cases} \quad \text{and} \quad \begin{cases} x^2+y^2=34 \\ xy=15 \end{cases}$$

Exercise 3. Find the value of:

$$\{[0.84+(1\tfrac{3}{50}-\tfrac{4}{52})\times 4.8-1.2\div 3.75]\div 2\tfrac{33}{65}+\tfrac{3}{20}\}\times(6.4\times 1.35-0.64)$$

At a secondary school in Kiev the following two problems were given to be worked out by the pupils during the class period:

Exercise 1. Solve the following system of equations:

$$\begin{cases} \dfrac{x}{y}+\dfrac{y}{x}=\dfrac{34}{15} \\ x^2+y^2=34 \end{cases}$$

Exercise 2. Write the equation having roots:

$$x_1=\frac{5}{4+\sqrt{6}} \text{ and } x_2=\frac{5}{4-\sqrt{6}}$$

At the end of the class period this class was assigned the following problems for homework:

Exercise 1. Simplify the expression

$$\left(\frac{-1}{\sqrt{1-x^2}}+\sqrt{1+x}\right)\times\frac{1+\sqrt{1-x^2}}{\sqrt{1+x}}$$

Exercise 2. Solve the following systems of equations:

$$\begin{cases} x-y=[illegible] \\ \dfrac{1}{x}-\dfrac{1}{y}=-\dfrac{1}{12} \end{cases} \quad \text{and} \quad \begin{cases} \sqrt{x}+\sqrt{y}=5 \\ \sqrt{xy}=6 \end{cases}$$

The teacher of this class had graduated in 1932 under a 4-year program in the Faculty of Mathematics at Kiev State University and has been a mathematics teacher in the schools since that time.

GEOMETRY

The purpose of teaching geometry in the secondary school is to give the pupils a systematic study of geometric figures in the plane and in space and to develop logical thinking, spatial imagination, and ability to apply this knowledge to practical situations. The practical work consists of measurement of lengths and plane areas and the determination of surface areas and volumes of solids, both those encountered in technology and those in practical daily living.

The study of geometry commences in grade 6 and continues through grade 10. In grade 6 are studied elementary notions, such as fundamental concepts, parallelism, and triangles, continuing with quadrilaterals and circles in grade 7. In grade 8,

pupils study ratios and proportions of segments, similar figures, and areas of polygons. In grade 9 regular polygons are taken up, followed by the metric properties of the circle. About two-thirds of study time in geometry in this grade is devoted to solid geometry, the study of which is likewise continued during the entire 10th grade.

Outside of Moscow in a rural school we visited an eighth-grade class in plane geometry which was being conducted in the electrotechnic laboratory room. The pupils were working on problems relating to the areas of polygons. In a 10th grade class in solid geometry in a school in Moscow the pupils were reviewing in preparation for their final examinations. Pupils were called by the teacher to the front blackboard, one at a time, to carry out steps in the solution of several problems concerning the inscription of geometric solids within other geometric solids. At the conclusion of the recitation three homework problems were assigned.

In another school we were shown a mathematics classroom in which no class was meeting at the time. A large slide rule was hung on the wall in the front of the classroom. A number of mathematics charts and geometric models were prominently displayed. There was a transit in the back of the room as well as some pupil-made measuring instruments.

TRIGONOMETRY

The purpose of teaching trigonometry in the Soviet schools is to give pupils essential information pertaining to trigonometric functions, solution of triangles, and the application of trigonometry in the solution of problems related to geometry, physics, and technology.

Trigonometry is taught in grades 9 and 10. In grade 9 are studied the trigonometric functions of an arbitrary angle, relations between trigonometric functions, and functions of composite angles, and in grade 10, solution of oblique triangles, inverse trigonometric functions, and trigonometric equations.

MATHEMATICS CURRICULUM

Following is a topical outline of the official curriculum with hours of instruction for mathematics taught in grades 5 through 10, inclusive, in the regular 10-year school:[17]

[17] *Ibid.*, pp. 25 ff.

Mathematics Curriculum, 10-Year School, grades 5 to 10

Grade 5

ARITHMETIC

(6 hrs. per week, total 198 hrs.)

1. Whole numbers (20 hrs. classwork; 8 hrs. homework)
2. Division of numbers (20 hrs. classwork; 8 hrs. homework)
3. Simple fractions (90 hrs. classwork; 36 hrs. homework)
4. Decimals (50 hrs. classwork; 20 hrs. homework)
5. Practical applications (6 hrs. classwork). The students and teacher will will use area near the school for measuring the distances with use of tape and by steps. They are taught to measure distances by eye, make angular measurements, and calculate areas.
6. Review (12 hrs. classwork; 6 hrs. homework)

Grade 6

(6 hrs. per week, total 198 hrs.)

ARITHMETIC

(4 hrs. per week in the first semester; total 66 hrs.)

1. Percent (20 hrs. classwork; 10 hrs. homework)
2. Proportion (32 hrs. classwork; 16 hrs. homework)
3. Review (14 hrs. classwork; 7 hrs. homework)

ALGEBRA

(4 hrs. per week in the second semester; total 66 hrs.)

1. Algebraic expressions; equations (16 hrs. classwork; 8 hrs. homework)
2. Positive and negative numbers (20 hrs. classwork; 10 hrs. homework)
3. Operations on integral algebraic expressions (30 hrs. classwork; 15 hrs. homework)

GEOMETRY

(2 hrs. per week; total 66 hrs.)

1. Fundamental concepts (14 hrs. classwork; 7 hrs. homework)
2. Parallelism (16 hrs. classwork; 8 hrs. homework)
3. Triangles (32 hrs. classwork; 16 hrs. homework)
4. Practical study (4 hrs.)

   The practical work consists of measurement of angles by eye, drawing parallel lines, and elementary surveying.

Grade 7

(6 hrs. per week; total 198 hrs.)

ALGEBRA

(4 hrs. per week; total 132 hrs.)

1. Factorization of polynomials (36 hrs. classwork; 18 hrs. homework)

2. Algebraic fractions (24 hrs. of classwork; 12 hrs. homework)
3. Equations of first degree with one unknown (34 hrs. classwork; 17 hrs. homework)
4. Systems of equations with two unknowns (28 hrs. classwork; 14 hrs. homework)
5. Review (10 hrs. classwork; 5 hrs. homework)

GEOMETRY

(2 hrs. per week; total 66 hrs.)

1. Quadrilaterals (26 hrs. classwork; 13 hrs. homework)
2. Circles (34 hrs. classwork; 17 hrs. homework)
3. Practical study (6 hrs.).

Grade 8

(6 hrs. per week; total 198 hrs.)

ALGEBRA

(4 hrs. per week first semester; 3 hrs. second semester, total 116 hrs.)

1. Powers and roots (44 hrs. classwork; 22 hrs. homework)
2. Equations of second degrees (42 hrs. classwork; 21 hrs. homework)
3. Functions and graphs (12 hrs. classwork; 6 hrs. homework)
4. Systems of quadratic equations with two unknowns (18 hrs. classwork; 9 hrs. homework)

GEOMETRY

(2 hrs. per week in first semester; 3 hrs, second semester, total 82 hrs.)

1. Ratios and proportions of segments (10 hrs. classwork; 5 hrs. homework)
2. Homotheticity and similarity (18 hrs. classwork; 9 hrs. homework)
3. Metric relations in triangles and circles (36 hrs. classwork; 18 hrs. homework)
4. Measurement of the areas of polygons (14 hrs. classwork; 7 hrs. homework)
5. Practical study (4 hrs.)

Grade 9

(6 hrs. per week; total 198 hrs.)

ALGEBRA

(2 hrs. per week; total 66 hrs.)

1. Limits (6 hrs. classwork; 3 hrs. homework)
2. Progressions (14 hrs. classwork; 7 hrs. homework)
3. Exponential and logarithmic functions (40 hrs. classwork; 20 hrs. homework)
4. Practical work in using the slide rule (6 hrs.)

GEOMETRY

(2 hrs. per week; total 66 hrs.)

1. Regular polygons (12 hrs. classwork; 6 hrs. homework)
2. The length of circumference and the area of a circle (10 hrs. classwork; 5 hrs. homework)
3. Solid geometry (40 hrs. classwork; 20 hrs. homework)
4. Practical study (4 hrs.)

TRIGONOMETRY

(2 hrs. per week; total 66 hrs.)

1. Trigonometric functions of an arbitrary angle (10 hrs. classwork; 5 hrs. homework)
2. Algebraic relations between trigonometric functions of the same angle. Formulas of reduction (16 hrs. classwork; 8 hrs. homework)
3. Trigonometric functions of a numerical argument (16 hrs. classwork; 8 hrs. homework)
4. Addition theorems (24 hrs. classwork; 12 hrs. homework)

Grade 10

(6 hrs. per week; total 198 hrs.)[18]

ALGEBRA

(2 hrs. per week; total 66 hrs.)

1. Permutations and the binomial theorem (12 hrs. classwork; 6 hrs. homework)
2. Complex numbers (12 hrs. classwork; 6 hrs. homework)
3. Inequalities (22 hrs. classwork; 11 hrs. homework)
4. Equations of higher degree (12 hrs. classwork; 6 hrs. homework)
5. Review (8 hrs. classwork; 4 hrs. homework)

GEOMETRY

(2 hrs. per week; total 66 hrs.)

1. Polyhedra (28 hrs. classwork; 14 hrs. homework)
2. Solids of revolution (20 hrs. classwork; 10 hrs. homework)
3. Review and solution of problems (18 hrs. classwork; 9 hrs. homework)

TRIGONOMETRY

(2 hrs. per week; total 66 hrs.)

1. Solution of oblique triangles (18 hrs. classwork; 9 hrs. homework)
2. Inverse trigonometric functions (14 hrs. classwork; 7 hrs. homework)
3. Trigonometric equations (16 hrs. classwork; 8 hrs. homework)
4. Practical exercises (6 hrs.)

[18] This curriculum was in use in about one-half of the schools in 1957–58. A newer curriculum requiring a total of 5 hrs. per week was in use in the other schools.

5. Review of trigonometry course and solution of geometric problems (12 hrs. classwork; 6 hrs. homework)

The Teaching of Physics

The official syllabus for the physics curriculum in the schools sets forth the following aims:

> To enable pupils to orient themselves correctly with regard to natural phenomena used to understand the basic industrial processes; to understand basic principles of mechanics, sound, heat, electricity, magnetism, and light; to understand atomic structure; to serve the goals of a Communist society; to prepare youth for future practical activity; to select a vocation or profession upon graduating; to understand the material world, the interrelations of physical phenomena and the objective laws of nature, and the formation of a materialistic world-view and scientific thought.

The syllabus goes on further to say:

> The formation of a scientific world view is inseparable from the struggle with religious prejudices and superstitions. Laws such as the conservation and transformation of energy, the law on the conservation of momentum, and the concept of the indestructibility of matter are basic for the atheistic education of pupils. The reactionary role of the church in the fight with progressive science should also be pointed out in the physics course.[19]

RELATION TO POLYTECHNIC EDUCATION

The study of physics is a necessary element in polytechnic education. Means of production, such as machines and mechanical and electric power, are based upon physical principles and processes. The close relationships between physics and the fundamentals of production is made clear to the pupils, and the application of physical laws and principles to technology is emphasized. It was a natural consequence, therefore, that we observed that many physics teachers were also teachers of such courses as electrotechnics.

An attempt is made, where possible, to give pupils an opportunity to apply their knowledge of physics while they are engaged in their production work. At the factory "Red Proletariat," in Moscow, we saw a number of pupils working with various kinds of calibration instruments under supervision of engineers and skilled technicians. Others were working with electric motors and machines. We were told that the pupils were expected to make minor adjustments and repairs to instruments and machines.

[19] R.S.F.S.R. Ministry of Education. *Programmy srednei shkoly. Fizika i Astronomiia.* (Syllabuses for secondary school. Physics and Astronomy.) Moscow, Uchpedgiz, 1958. 53 p.

ASPECTS OF THE PROGRAM

The study of physics commences in the 6th grade and continues in every grade thereafter through the 10th grade. Elementary notions of mechanics, heat, and electricity are taught in grades 7 and 8. These same topics are likewise taught in grades 8, 9, and 10 but in greater depth and more systematically with the aid of the mathematics which has been learned. Alternating current, electromagnetic vibrations and waves, optics, and atomic structure are topics which are introduced for the first time in the 10th grade.

GRADE 6

The course in physics begins in the sixth grade with an introduction to properties of matter. Pupils learn units of measurement and such fundamental concepts as length, area, volume, mass, weight, and force. By means of specific gravity, pupils acquire a knowledge of light and heavy materials.

Concepts of pressure and force are explained by the aid of such practical applications as building foundations, needles, knives, cutters, and chisels. Liquid pressure is explained by means of Pascal's Law. The bouyant forces which act upon a submerged body are calculated in accordance with Archimedes' Law.

In the unit on mechanical motion are taught concepts of speed with examples taken from technology. In the theme, work and power, pupils learn about simple mechanisms and their applications to levers and pulleys. Supported by examples of water power and winds, pupils are taught the distinction between potential and kinetic energy.

The program for the sixth grade requires the completion of the following 7 experiments:

1. Measurement of body dimensions by means of a ruler.
2. Determination of the volume of a solid body by means of displacement of a liquid.
3. Weight of bodies.
4. Measurement of force with the aid of the spring balance.
5. Use of the plumb line.
6. Use of the barometer in the calculations of atmospheric pressure.
7. Use of simple mechanisms, like levers and pulleys.

GRADE 7

The first part of the course in physics in the seventh grade is devoted to the study of heat. First, pupils are given elementary

notions on the structure of matter, molecules, liquids, and gases. Then they are taught about the expansion of bodies due to heat, the transfer of heat, and the measurement of heat. Various kinds of heat engines are explained and illustrated.

The second half of the course concerns electricity. Pupils learn how an electric current is produced and how current, resistance, and voltage are measured. Ohm's Law is studied, and pupils become acquainted with electromagnetic phenomena. Seven experiments are required, and pupils acquire skills and knowledge in the following techniques:

1. Measurement of temperature by means of a thermometer.
2. Use of a calorimeter.
3. Graphical representation of temperature occurring during the heating of a body.
4. Operation of the steam engine and identification of its parts, such as valves, governors, etc.
5. Operation of the internal combustion engine and the identification of its parts.
6. Rules of safety during experiments with heat sources and electric equipment.
7. Ability to read electric instruments.
8. The assembly of the galvanic battery.
9. Use of the ammeter.
10. Use of the voltmeter.
11. Various type of rheostats.
12. Understanding of the calibration of electric light bulbs.
13. Use of thermoelectric devices.
14. Determination of the polarity of the poles of a permanent magnet by means of the magnetic needle.
15. Determination of the polarity of the of an electromagnet by means of the direction of the current in the coil.
16. The wiring of an electric bell.

GRADE 8

The course in the eighth grade commences with a study of mechanics. Pupils learn about uniform motion, uniformly accelerated motion, and inertia, as well as the resolution and composition of forces. Under the topic of mechanical energy they study about simple machines and the law of equilibrium. Included among the required demonstrations and experiments in this grade are:

1. Measurement of the dimensions of a body by use of the micrometer.
2. Weight of a body.
3. Use of the stop watch.
4. Use of the tachometer.
5. Construction and reading of graphs.
6. Measurement of the power of an electric motor by means of the break-band.

GRADE 9

The study of mechanics is completed during the first part of the ninth grade. The pupils learn about curvilinear motion and centrifugal force. The next unit is on vibrations and waves which lead to a study of the phenomenon of sound. The actions of liquids and gases are illustrated by means of the carburetor and the water pump.

In the theme, molecular physics and heat, the pupils begin a study of molecular kinetic theory as a basis for understanding thermal phenomena. They are required to know and characterize the mass and size of molecules and also the number of molecules in a cubic centimeter of gas. Ten experiments and demonstrations are required to be performed, including the following:

1. Construction and performance of the carburetor.
2. Use of the calorimeter.
3. Determination of the humidity of the air by means of the hygrometer.
4. Construction and performance of the steam engine.

GRADE 10

The unit of electricity covers electric and magnetic fields and laws relating to them, ionization, and charging of particles. The pupils have already received some instruction in these topics while studying chemistry in the seventh grade. In studying direct electric currents, they receive a picture of the nature of electric currents in metals, gases, and in the vacuum.

In the next unit the pupils learn about the phase, period, and frequency of alternating currents. Particular attention is given to three-phase current. In the topic of electromagnetic oscillations and waves, attention is concentrated on transformers and magnetic fields produced by coils. The principles underlying radar are explained. Emphasis is given to the great contributions made by scientists and inventors and their applications to the advancement of technology.

The concluding unit in the physics program is on optics and

Figure 2-5.—Eleventh graders in electrotechniques laboratory.

atomic structure. The pupils learn about the reflection and refraction of light and the effects of light. The photoeffects of light are explained by means of luminescence and chemical action, with reference to the experimental work of P. N. Lebdev. In the study of structure of the atom, pupils are taught about energy levels of electrons, isotopes, and the peaceful uses of atomic energy. Thirteen experiments and demonstrations are required, among which are the following:

1. Assembly of electric circuits
2. Operation of the electric motor
3. Use of the photometer
4. Determination of the focal length of a lens
5. Assembly of the telescope and microscope
6. Use of the spectroscope

VISITS TO CLASSES

We had an opportunity to observe physics classes and facilities during our visit. In one class which was following the new experimental 11-year program, students were reviewing topics for final examinations. They were discussing the nucleus of the atom and the arrangement and motion of the electrons about it. The instructor was explaining the equation $h\nu = E_1 - E_2$ and

how a radiation of a certain frequency was emitted when an electron shifted from one energy level to another. A pupil was called upon to explain why X-rays have such high frequency. A film was then shown on the production and use of atomic energy. The teacher proudly told us that the most talented physics pupil in the class, in the entire school in fact, was a daughter of a working mother.

Another physics class we visited was a 10th year physics class at a regular 10-year school in Kiev, composed of 22 girls and 1 boy. The instructor was an older man, and he was explaining how the mass of the nucleus corresponds to the atomic number in the periodic table. He discussed the energy levels of the electrons and how isotopes differed from the regular atom. The instructor lectured during the entire period, and the pupils took notes. We examined the textbook being used in the course.[20] The chapter headings were as follows:

Part I. Electricity and the Electromagnetic Field

1. Electricity
2. Magnetic fields produced by electromagnetic induction
3. Properties of electricity
4. Electromagnetic waves

Part II. Atoms and Optics

1. Dispersion of light
2. Spectra
3. Optical instruments
4. Light waves and wave propagation
5. Effects of light
6. Atomic structure. Atomic fission.

An example of class quizzes was one which had recently been given in an eighth grade physics class.

A Quiz Given in Eighth Grade Physics

1. The radius of a shaft is 6 centimeters, and the radius of the crank handle is 20 centimeters. The efficiency of the hoist is 90 percent. What is the actual mechanical advantage of the hoist?
2. What force must be applied to the rope of a single fixed pulley in order to raise at a uniform rate a weight of 96 kilograms if the efficiency of the pulley is 0.8?
3. A screw which is part of a vise has a pitch of 5 millimeters. As the screw is turned, it meets a resistance of 10 kilograms. How much work

[20] The textbook used was *Course in Physics*, Part III, by A. V. Peryshkin and others, in a Ukrainian edition of 1958.

is performed on the screw during two revolutions? What force must be exerted at the end of the handle attached to the head of the screw in order to turn the screw if the radius of the handle is 10 centimeters?

PHYSICS CURRICULUM

Following is a topical outline of the official curriculum with hours of instruction for physics taught in grades 6 through 10, in the regular 10-year school:[21]

Physics Curriculum, 10-Year School, grades 6 to 10

Grade 6 (68 hrs., sic)

I. MECHANICS

1. Introduction (1 hr.)
2. Measuring length, area, and volume (4 hrs.)
3. Force of gravity (3 hrs.)
4. Specific gravity (5 hrs.)
5. Force and its measurement (3 hrs.)
6. Pressure (16 hrs.)
7. Forces acting on bodies submerged in liquid and gas (6 hrs.)
8. Mechanical motion (7 hrs.)
9. Work and power (4 hrs.)
10. Simple machines (6 hrs.)
11. Energy (2 hrs.)
12. Two excursions (6 hrs.)

Grade 7 (102 hrs.)

II. HEAT

1. Introduction: Structure of matter, molecules, liquids, gases (1 hr.)
2. Expansion of bodies due to heat (4 hrs.)
3. Transfer of heat (3 hrs.)
4. Measuring amount of heat (10 hrs.)
5. Changes in state of matter during heating and cooling (5 hrs.)
6. Heat engines (8 hrs.)

III. ELECTRICITY

1. Elementary notions (4 hrs.)
2. Electric current (6 hrs.)
3. Current, resistance and voltage (15 hrs.)
4. Energy and power of current (7 hrs.)
5. Electromagnetic phenomena (24 hrs.)

[21] *Programmy srednei shkoly. Fizika i Astronomia.* (Syllabuses for secondary school: Physics and Astronomy), *op. cit.*, pp. 21 ff.

6. Excursions (6 hrs.)
7. Review (9 hrs.)

Grade 8 (102 hrs.)

I. MECHANICS

1. Uniform rectilinear motion (10 hrs.)
2. Uniformly accelerated motion (16 hrs.)
3. Inertia. Composition and resolution of force (18 hrs.)
4. Force, mass and acceleration (10 hrs.)
5. Interaction of bodies (10 hrs.)
6. Mechanical energy (17 hrs.)
7. Practical exercises (10 hrs.)
8. Excursions (6 hrs.)
9. Review (5 hrs.)

Grade 9 (136 hrs.)

I. MECHANICS (continued)

10. Curvilinear motion. Rotary motion (17 hrs.)
11. Vibrations and waves (11 hrs.)
12. Sound (6 hrs.)
13. Action of liquids and gases (9 hrs.)

II. MOLECULAR PHYSICS AND HEAT

1. Principles of molecular-kinetic theory of the structure of matter (3 hrs.)
2. Heat and work (10 hrs.)
3. Expansion of a body during heating (4 hrs.)
4. Properties of gases (12 hrs.)
5. Properties of liquids (6 hrs.)
6. Properties of solids (8 hrs.)
7. Changes in the aggregate composition of matter (18 hrs.)
8. Heat engines (10 hrs.)
9. Practical exercises (10 hrs.)
10. Excursions (6 hrs.)
11. Review (6 hrs.)

Grade 10 (148 hrs.)

I. ELECTRICITY

1. Electrical charges and the electrical field (17 hrs.)
2. Electrical current (29 hrs.)
3. Magnetic field and electromagnetic induction (11 hrs.)

II. ALTERNATING CURRENT, ELECTROMAGNETIC VIBRATIONS, AND WAVES

1. Alternating electric current (16 hrs.)
2. Electromagnetic vibrations and waves (10 hrs.)

III. Optics and Atomic Structure

1. Diffusion of light (5 hrs.)
2. Reflection and refraction of light (10 hrs.)
3. Optical instruments (5 hrs.)
4. Wave properties of light (9 hrs.)
5. Effects of light (5 hrs.)
6. Structure of the atom (8 hrs.)
7. Practical exercises (6 hrs.)
8. Excursion (3 hrs.)
9. Review (14 hrs.)

The Teaching of Astronomy

Astronomy is taught one hour each week in the 10th grade. As explained in the official syllabus for the course, the purpose of teaching astronomy in the secondary school is to give pupils an elementary understanding of the universe, the movement of celestial bodies, and the position of the earth relative to them. The study of astronomy should also contribute to a refutation of religious beliefs.[22]

The first unit is on the diurnal rotation and annual revolution of the earth. The pupils learn about the apparent motion of the sky and the concepts of latitude and longitude in the determination of geographic locations and in navigation.

In the second unit, on the basic methods of astronomy, pupils are given an elementary understanding on how astronomical distances to the various celestial bodies are determined. They are taught the role of spectral analysis in the study of physics of the stars, with special emphasis on the sun. The 100 years of work of the Pulkov Observatory and the contributions of such Russian and Soviet scientists as Lomonosov, Struve, Bredikhin, Belopolskii, Shternberg are pointed out.

The motions and characteristics of the moon, planets, comets, and meteors are treated in the study of the solar system. Terrestial phenomena caused by the sun are discussed. Stars and star systems, their nature and movements, are taken up in the study of the structure of the universe. The importance of photography and spectral analysis in modern astrophysics is stressed.

[22] *Ibid.*, pp. 48 ff.

The subject of astronomy is concluded by a brief treatment of the theories concerning the origin of the universe and the evolution of celestial bodies.

ASTRONOMY CURRICULUM

Following is a topical outline of the official curriculum with hours of instruction for the teaching of astronomy in the 10th grade:[28]

Astronomy Curriculum, 10-Year School, Grade 10

(Total hours, 34)

Introduction (1 hr.)

I. Diurnal and annual changes in the appearance of the sky. Motions of the earth. Practical application of astronomy (9 hrs.)
Observation (2 hrs.)

II. Basic methods of astronomy (4 hrs.)

III. Solar system (8 hrs.)
Observation (1 hr.)

IV. Stars, star systems, and structure of the universe (4 hrs.)
Observation (1 hr.)

V. Origin and evolution of celestial bodies (2 hrs.)
Review (2 hrs.)

Pedagogical Research

Soviet educators do not believe that their curriculums and teaching methods have been by any means perfected. Concrete evidence of their dissatisfaction with them is clear in view of the sweeping reforms which are planned and the numerous critical articles which appear in the newspapers and educational journals. Specific references to this dissatisfaction have already been made in the preceding discussions, and some sentiments along this line were expressed to us in our talks with Soviet educators.

In order to overcome shortcomings and inadequacies, a significant attempt is being made in the numerous pedagogical research institutes located throughout the U.S.S.R. to study problems of education in the schools and means of effecting improvements. These research institutes are staffed by substantial numbers of subject-matter specialists who have broad backgrounds in teaching and research and who are employed full-time

[28] *Ibid.*, pp. 51 ff.

to do this work, unencumbered by other responsibilities. We had an opportunity to visit these institutes in Moscow, Leningrad, and Kiev, and talk to some of their research workers and learn from them what they are doing. Since these specialists are working on new curriculums and methods which have significant implications for future science and mathematics education in the schools, the following pages will summarize what we learned from them.

EDUCATIONAL RESEARCH ON SUBJECT-MATTER TEACHING

The various pedagogical research institutes have certain assigned responsibilities for research. The Scientific Research Institute of Pedagogy in Leningrad has the task of conducting research on subject-matter teaching. We made two visits to this Institute during our stay in Leningrad and talked to a number of research specialists in the sectors of science and mathematics. We were told by all of these research workers that their main problem now was to relate the teaching of their subjects to the new emphasis on polytechnic education.

Mathematics.—In the mathematics sector the specialist in charge explained to us that one of his tasks was to make higher mathematics simple enough for secondary pupils to understand but that his effort was complicated by the fact that it has never been determined what minimum mathematical knowledge should be possessed by a cultured person. This, he said, is a problem on which he has been working for 50 years, and he showed us a book that he had written 30 years ago on mathematics which he thought should be taught in the secondary schools.

Like some mathematicians in our country, he complained that mathematics is being taught just as it was centuries ago. He felt that there was imperative need that mathematics be taught in tune with modern times and technology. He emphasized the importance of visual concepts. Concepts of geometry, he felt, can be integrated with concepts of arithmetic through diagrams and visual aids. There should be unity in speech, action, and thinking in mathematical study, with transition from simple to complex ideas. He showed us some of the charts that he had developed and which were on display in his office, showing how to achieve these objectives.[24]

Biological Sciences.—There are six research specialists working

[24] Recent publications by this specialist, P. A. Kompaniets, are: *Simple Graphical Calculations in the Course of School Mathematics*, Moscow, Uchpedgiz, 1957, 60 p., plus plates; and *Some Problems in the Course of School Mathematics*, Publication No. 95, Moscow, "Izvestiia pedagogicheskikh nauk R.S.F.S.R.", 1958. 292 p., plus plates.

in the sector of biological sciences. The chief of the sector outlined to us the three major problems with which this sector was concerned:

1. Development of individual thinking in the pupils.
2. Effective use of visual aids.
3. Practical experience, not only by means of the school garden plot but also by laboratory work.

For 30 years this sector has been doing research work on the school plot theme. We were shown a diagram of what was considered an ideal school plot. It consisted of a rectangle with an area of half a hector and contained six divisions: (1) Decorative plants; (2) field plants (wheat, corn, barley, etc.); (3) garden and vegetable plants; (4) fruit trees; (5) plants and herbs used in the study of ecology and genetics; and (6) zoological section (bees, chicken, rabbits, birds, etc.). A fence of shrubbery and small trees enclosed the plot.

The chief of the sector showed us some of the publications produced by his sector, including his own books on botany, how to teach botany, and how to work with children on school plots. Two of his books on popular reading for children are examples of the efforts of these research workers: *Path to the Woods* and *Following the Tracks of Robinson Crusoe.*

Physical Sciences.—In the sector of physical sciences we were told that their main problems at the present time are:

1. How to teach the fundamentals of physical science.
2. How to connect these subjects between themselves.
3. How to teach the fundamentals of production in order to achieve true polytechnic education.

The research specialists in this sector are working on both the theoretical and practical aspects of these problems. Among other things they are studying how school laboratories and display cases should be organized and equipped.

The sector chief told us that Soviet educators do not believe that polytechnic education should be of a trade character. Rather, the aim of work in the factory or plant should be to teach the fundamentals of production in a real polytechnic sense. For this reason an attempt is being made to establish a close relationship between the teachers in the schools and the engineers in the factories in order that this goal can be achieved. One research specialist, a woman, visits both the schools and the factories. She conducts experiments which are designed to test the effectiveness of various educational practices. One of her recommenda-

Figure 2-6.—Members of Pioneer Club from 11-year school.

tions was that the pupil should master not only one operation or skill, but rather a complex of them. In the plant itself, an engineer should teach the theory, using pertinent literature, visual aids, simple projects, etc., but a foreman should be in charge of practical instruction.

We were shown some of the research work done in the sector of physical sciences, including a display of equipment which has

been designed to assist in the teaching of physics, chemistry, and astronomy. We examined two of the books produced in the sector, one by the sector chief, on *Methods of Teaching Physics*, and the other, by the woman specialist referred to, on *Mechanics and Machine Technology*.

EDUCATIONAL RESEARCH ON METHODS

Educational research on methods is the primary function of the Pedagogical Research Institute of Methods in Moscow. We made two visits to this institute, the first time on May 12 to talk to the director and some of his key staff on overall aspects of their work and a second time on June 4, after our return to Moscow, to talk to some of the research specialists in science and mathematics.

The director outlined to us the organization and the work of his institute which employs 120 research specialists. The institute is divided into sectors covering various fields of knowledge, each headed by a chairman and consisting of between a half dozen and a dozen specialists. In the sector of mathematics and drawing, for example, there are 10 specialists in mathematics and 2 in drawing, and in the sector of physics there are 8 specialists. The common task of all sectors, he explained, was the preparation of programs of study, syllabuses, visual aids, design and arrangement of facilities and equipment, and development of effective methods of teaching all subjects in all types of schools.

EXPECTED INNOVATIONS IN CURRICULUMS

The director of the Pedagogical Research Institute of Methods in Moscow gave us a general picture of trends in Soviet science and mathematics education, and we obtained more detailed and specific information in our later meeting with the specialists themselves.

Due to the new reforms being brought about by the present emphasis on polytechnic education, the most important problem facing their research workers in science and mathematics now is, according to Russian educators, subject-matter content. In order to make science and mathematics more closely connected to practical life, curricular changes are being planned in all subjects.

Mathematics.—There will not be much change in the arithmetic curriculum which extends from the first grade to the middle of the sixth grade. In the fifth grade instruction in calculation with decimals and ordinary fractions will be strengthened. In the present curriculum ordinary fractions are taught before decimals.

In the new proposed curriculum decimals will be taught first and an increased amount of time given to them.

Substantial changes are being planned in other subjects in mathematics. Subject-matter now studied in grades 8, 9, and 10 will henceforth be studied in grades 9, 10, and 11 of the new 11-year schools as they are established in lieu of the former 10-year schools. However, some parts of the material formerly studied in grade 9 will be transferred to grades 5 through 8, and some of the material in grades 5 through 8 transferred to the senior grades. Of course, the transferred material will be taught consistent with the maturity of the pupils at each grade level. Part of the material now taught in the senior grades will henceforth be excluded, and in its place will be given some new material never before taught. These changes, it was emphasized, were necessary in order to link the study of mathematics more closely to practical life.

According to the planning of the mathematics specialists with whom we talked, the new mathematics programs in the senior grades will be as follows. In grades 9, 10, and 11 the mathematics subjects studied will be known as (1) algebra and elementary functions and (2) geometry instead of as formerly (1) algebra, (2) geometry, and (3) trigonometry. No longer will trigonometry be regarded as a separate subject by itself. The topics presently studied in trigonometry will not be abandoned, but rather they will be reorganized and divided between geometry and algebra and elementary functions. The applications of trigonometry to geometry, such as the solution of triangles, for example, will be taken up in the study of geometry.

The new principal emphasis will be on the theory of functions, and it is for that reason that algebra has been revamped into algebra and elementary functions. The notion of functional dependence between variables and their graphical interpretations is considered to be fundamental and insufficiently treated in the present curriculum.

The amount of logarithmic calculations will be reduced. In its place some new material will be added. For example, the following types of functions will be added: $y = A \sin (kt + B)$ and $y = A \cos kt + B \cos kt$. More emphasis will be placed on the graphical solution of such problems as $\sin x = kx$ and $\log x = kx$.

The new course in the ninth grade, algebra and elementary functions, will begin with a review of previously learned material. Soviet teachers feel that the new material planned for the fifth through eighth grades will be more understandable to the pupils.

They also believe that some of mathematics studied in these grades is too difficult and lacks a logical basis which they hope will be provided through the curriculum reform. Henceforth in these grades more systematic attention will be given to the development of the real number system, roots of equations, and concepts of equalities and inequalities. In grades 9 and 10 will be studied trigonometric, logarithmic, and exponential functions. Graphical analysis will be emphasized in the study of these functions, and a concerted effort will be made to establish the connection between them.

In the 11th grade will be introduced the beginning elements of calculus, which is not at the present time a part of the regular mathematics curriculum. The concept of a derivative will be taught, together with its applications in solving problems of rates of change, slopes, and maxima and minima of functions. Experiments have previously been conducted by some of the research specialists in the teaching of this new material in some of the experimental schools attached to the research institute. The experiments did not prove too successful, primarily because the teachers were not sufficiently prepared to teach the new topics and the new material was not adequately adapted to the grade level of the pupils. However, the specialists feel that the difficulties previously encountered are being overcome.

In regard to geometry, the ninth grade will commence with a review of plane geometry. In this grade the main themes will be the notions of symmetry, similitude, transformations (translations and rotations), and geometric properties of plane figures (axes, foci, etc.). Material in the present geometry curriculum will be studied but with new approaches and greater depth. For example, the study of the metrical properties of triangles and circles will be transferred to the latter part of the curriculum where they will then be investigated with the aid of trigonometry. In grades 10 and 11 pupils will take a course in solid geometry.

Physics.—In physics a number of changes are being planned. In beginning physics in grades 7 and 8 the program in mechanics and electricity will be somewhat expanded. The study of sound and light phenomena will be introduced, and pupils will be given elementary concepts of atom structure. The number of obligatory laboratory assignments will be increased as well.

The instruction in physics in grades 7 and 8 will be from the elementary notions standpoint. Systematic study of physical principles with the aid of mathematics will take place in grades 9 through 11. The curriculum in these grades will provide for

the study of such problems as physics of the atom, ultrasound, semiconductors, and physical properties of plastics and their use in industry. Information on artificial earth and sun satellites will be presented.

The total number of academic hours devoted to physics in grades 6 through 11 in the new proposed curriculum is 608, of which 80 to 100 hours are devoted to laboratory work. This compares with 550 academic hours in the present curriculum, of which 50 to 60 hours are in laboratory work.

Chemistry.—The chemistry program which commences in the seventh grade is being considerably broadened. The course in grades 9 through 11 will acquaint pupils with the properties and structure of high-molecular compounds, their classification, and the basic methods of their synthesis. Particular attention will be paid to plastics, artificial and synthetic fibers, rubber, and the most typical methods of their commercial production.

Biology.—The program in biology will be expanded in the new curriculum. In grades 5 through 8 pupils will learn about flora and fauna and receive elementary knowledge of man's anatomy and physiology. A new subject, nature study, will be introduced in grade 4 in place of geography and natural sciences. It will devote considerable time to the study of local natural conditions and give the pupils the rudiments of natural sciences and geography. A new subject to be introduced in secondary schools, fundamentals of general biology, will be given in grade 9 for 3 hours a week.

Proposed distribution of hours.—The reader should bear in mind that the general 11-year school curricular reforms which have just been discussed are proposals which there seems good reason to expect will be implemented. The distribution of hours

Table 3.—Distribution of hours in science and mathematics in the proposed new 11-year curriculum (urban school)

Subject	Number of hours a week in grades										
	1	2	3	4	5	6	7	8	9	10	11
1	2	3	4	5	6	7	8	9	10	11	12
Mathematics	6	6	6	6	6	6	6	5	4	4	4
Nature study				3							
Biology					2	2	2	2	3		
Physics						2	2	3	4	4	2
Chemistry							2	2	2	3	2
Astronomy										1	

in science and mathematics in the new proposed curriculum is given in table 3. An indication that the new curriculum is being officially approved was a news article in *Pravda* on August 29, 1959, stating that the new school reform is in effect.

How new curriculum will be introduced.—We were told by the Soviet educators that the new curricular changes will be introduced by stages. The new curriculum will first be adopted in grades 1 through 5. Then, the new curriculum will be introduced gradually through successive grades until the entire reform is in effect by 1965 in all 11-year schools. Experimentation with the details of the curriculum in higher grades is to continue until they are finally and officially approved.