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ABSTRACT

This paper discusses the relationship between economic development and education in developing countries, with major emphasis on the experience of the U.S.S.R. between 1917 and 1968. Separate sections of the paper examine the economic role of education in developing nations, the historical development of technical education in the U.S.S.R., the economic and educational planning process in the U.S.S.R., the training of research personnel in the U.S.S.R., the training of teachers in the U.S.S.R., and some practical considerations in planning technical education for developing nations. In addition, the appendix contains a series of statistical tables that summarize a variety of educational and economic data for the U.S.S.R. from 1913 through 1967. (JG)

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No. 34 THE PLANNING OF TECHNICAL EDUCATION IN DEVELOPING COUNTRIES : LESSONS FROM THE USSR

by Professor S.A. Shumovsky

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by

Professor S.A. Shumovsky

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The economic role of education in developing nations

During the last few decades the main tasks of newly independent countries have been to boost their economic growth, develop their culture, improve their social standards and seek a higher standard of living. As a basis for this improvement, and especially in technical and social development, the role of education cannot be over-estimated. Even with abundant material and financial resources, it is just not possible to make any actual progress unless enough educated people are able to put the resources to good use.

In this connexion I want to emphasise that education in the Soviet Union has always been given a top priority. It is our view that no matter how small is the amount of finance available in a country, first priority should go to education; there is no other field of investment which will give such a return as that from education. Numerous studies over the last few years have shown that the level of education in any labour force (from unskilled workers to skilled technicians) is a direct factor influencing productivity of this force.

The development of technical education in the USSR

Fifty years ago, some areas of the Soviet Union were at such an early stage of development that they were comparable with many countries that are just beginning to develop today. For example, in a large section of the Soviet Union bordering on Persia, Afghanistan, India and China, education in 1917 - at the time of the revolution - was exceptionally poor. In these areas nearly 99 per cent of the people were illiterate; the people did not even have their own alphabet, nor their own written language. They were mostly nomads, leading a very primitive life, going with their cattle from one place to another, perhaps growing a few crops. In other words this area of the Soviet Union was comparable with certain developing countries today in other regions of the world. In 1917, in the Soviet Union as a whole, over 70 per cent of the people were illiterate.

Appendix I shows that in the Soviet Union immediately before the Revolution, only 9,656,000 students were in school, out of a total population of about 175 million. And it was normally only four years of schooling with just a small number going further and completing seven or eight years in school.

At that time Russia was basically an agricultural country and with only very limited industry. Most industrial enterprises, in fact, were under foreign control. In my home city, for example, the gas undertaking was run by a Belgium company, the tramways by a French company, a big plant for producing agricultural machinery by a German company, and so on. The result of this was that as most of the industrial machinery was brought from abroad, a large number of technical personnel, especially the higher technical personnel, were foreigners.

But it is necessary to point out, that although the number of engineers trained in the country before the Revolution was small, the quality of engineering education was always very high. It was common practice for a Russian engineer with a Russian degree to go to France, England, Germany or the United States and his diploma was valid in those countries on the same level as local engineering diplomas. Thus, although the Russian engineer was coming from what was an underdeveloped country, his qualifications were equal and sometimes superior to those of his counterparts in the most highly developed countries.

During the first World War, and during the Civil War, Russian industry was practically ruined, and it was only in 1926 that Soviet industrial production had regained its pre-war level. But the difference between 1926 and 1914 was that now industrial production was geared to plans which had been formulated by the government and carried out by Russian engineers and workers. It was no longer a foreign industry. And by 1926 most of those technical educational establishments which had been run down in the first World War and during the Civil War were back to full capacity and training engineers just as good as in pre-war days and in sufficient numbers to match the needs of industry. The difference was that whereas before the Revolution higher education courses were of unlimited duration (you could stay, if you wished, for 10 years in a university or technical institution, taking one subject after another) more rigid rules were introduced in 1926 concerning examinations, methods of instruction, length of courses and the standard of quality that had to be mantained. Briefly, the country was once again training engineers of high quality but still small in number.

At that time the First Five-Year Plan was being devised and put into operation which called for a rapid expansion and very high rate of growth of industrial production. The very large number of engineers and technicians required to fulfill the Plan represented such a great leap forward that, for a time, some people abroad believed that the Plan was a fake and that nothing would happen. In fact, the First Five-Year Plan materialized in four years. But special methods had to be used to train such a large number of engineers and technicians in so short a time. In normal circumstances - depending on the field of training - it usually takes 5 - 5 1/2 years to train an engineer after he has graduated from secondary education. But the country at that time simply could not afford to wait five years because this would have meant we couldn't operate the plants which had to be ready by a particular time. So it was decided to make a change in the educational system and shorten the training from 5 to 3 or 3 1/2 years. The quality of training, however, had to be kept just as high as before because there was no point in investing billions of roubles in building good factories and then not getting a satisfactory level of production because of poor engineers. So there was a country-wide drive to train engineers out of well-qualified workers. The difficulty was that many of them had not had any High School education, so the country created a number of so called 'workers faculties' which provided specialized courses leading to admittance to technical institutions. In these technical institutions the curriculum was changed so that the students

were given a good grounding in the basic essentials (mathematics, physics, etc.), but the actual engineering curriculum was made somewhat narrower and more specific than before. Instead of, for example, following a wide course of general electrical engineering, an engineer would be trained to work in a particular field of electrical engineering. So, by making the course more specialized, and taking people who had already had five, ten or fifteen years of practical industrial experience, it was possible to cut the length of the course. This meant that we could train a very large number of engineers in a shorter time and almost cover all our needs.

In order to cut the period of development further and have access to the latest designs being produced in the world, the Soviet Union - at the time of the First Five-Year Plan - used foreign assistance to a considerable extent on a contract basis with some of the most developed countries. These countries were thus helping the USSR to build large-scale industrial plants - automobile plants, electrical plants, chemical plants, aeroplane plants, etc.; by this method, Soviet factories were modernized almost over-night. In the manufacture of aeroplanes, for example some designs and technological methods were bought from abroad, thus cutting out five or six years of development. At the same time, the Soviet Government decided to send the most promising Russian students abroad, to gain experience in various fields of engineering. By such means the First Five-Year Plan was fulfilled.

We then reached the period when we wanted to implement on a larger scale our own technical ideas and our own technological processes, using the benefit of experience gained in previous years. Technical education was thus reformed in 1936. The curriculum for technical education was revised on a broader basis, covering a five to six-year course with great emphasis placed on quality, on creative aspects and on the research side.

Then the World War came and a large number of industrial plants were completely demolished. The immediate post-war period was thus a time of reconstruction of what was lost and also of building up-to-date plants in some new fields (radio-electronics and atomic energy, for example, were developing just at that time). Thus once again, many engineers and technicians were required at a high standard.

In this situation we applied some additional methods to those used before. First, we had regular day-time education with an increasing number of students. In addition, a drive was launched for the development of part-time and out-of-school education by correspondence, and today there is probably no other country in the world where these types of education are being practiced on such a wide scale. Our experience in the USSR shows that it is an essential measure if you want to have a large number of technical personnel of high quality. In addition to youngsters who come at, say, the age of 17 or 18 to educational institutions to be trained as engineers, it is also wise to have some older people, with more industrial experience who are given the same type of education. And of course in any country, and the Soviet Union is no exception, not everyone is able or wishes to study after reaching the age of 17. Some of them do not have any particular desire for higher education when they are 17 but that desire may

develop later; for such people there is thus a possibility to study without leaving their jobs. I should emphasize that the quality of the course is the same whether a student takes a day-time, evening or correspondence course, he gets the same diploma and no mention is made in the diploma as to which course has been taken. A diploma is given from a particular engineering institution and most institutions have all three divisions, day-time, part-time and correspondence. The only difference from full-time study is that the length of the course is twelve or eighteen months longer.

Students taking correspondence courses in the USSR (and at the present time about 35 per cent of all engineering students in the Soviet Union are taking correspondence courses) are guaranteed by law to be able to work the same shift each day at their place of employment so that there are no problems about, for example, following a course of televised lectures or attending their local institutes at regular times for such things as practical work and the sitting of examinations. Naturally, correspondence students continue to receive their full pay from their employers during their studies and the employer must also pay for the additional time and travel connected with attending laboratory practice and examinations. In all, correspondence students are entitled to about 1 year of additional paid vacations during their six years of study.

In such ways as the above, the number of engineers being trained can be increased by very large amounts. Appendix 4 shows that the number of students being trained as engineers has grown from 289,000 in 1941 to 1,325, 100 in 1964. Similarly, the number of technicians being trained has increased from 320,100 in 1941 to 2,292,700 in 1964.

By 1967 the number of students in higher education had reached a little over 4,100,000 and the number of students in techikums had reached 4,000,000. Thus, about 8,000,000 are being taught now and the figure is increasing by about 7 per cent annually, enough to cover all industrial needs.

Currently our main problem is to produce high quality engineering personnel so that they are able to follow the very rapid development in science and the very rapid changes in technology. Engineers who are trained in only particular ways of scientific thinking are not flexible enough to be able to use or suggest new developments. We have thus put a major emphasis on quality. This means that we have had to change our methods of training again and to make changes in our curricula. Let me just mention two aspects:

First, we now pay major attention to giving engineers a wide knowledge of mathematics, physics and chemistry - much wider than engineers would have known, say 10, 15 or 20 years ago. And it is not simply a wide knowledge that is required of today's engineer but he has to know how to approach and solve problems by applying his mathematical knowledge. It is the same thing in physics; he not only has to know the laws of physics very well but he has to be able to

apply them in practical situations. So this is the first principle - engineering and technical students must have a very good background in natural sciences and this gives them flexibility in solving problems.

Secondly, we now request each student in engineering institutions to participate in actual research being carried out, starting from his third or fourth year. In higher education there are now over 300,000 professors and teachers who are involved in scientific research and each of them has a group of students working with him, taking part in actual research. We give very great attention to the participation of students in research because only through research is the student gaining the ability to solve completely new problems.

The Planning Process

Planning, in my view, is one of the most important prerequisites for any country that wants to develop rapidly.

Since the early days of the Soviet Government, top priority has been given to planning and a state Planning Commission was set up by the Government in 1917-18. Although planning was difficult during the period of the Civil War, detailed plans were afterwards worked out and implemented that lead not only to a rapid rise in industrial production but to an improvement in the economy in general.

Our policy in the Soviet Union is that once a plan is approved, then it automatically becomes the law of the country. In this way, and as the economy is highly centralised, the planners can ensure that all sections of the plan are moving forward at the required rate.

Planning in the Soviet Union takes the following structure :

First, there is long-range planning. In order to carry out a plan, one often needs longer than a five year period. For example, the development of large power plants or hydro-electric stations takes at least seven to ten years between conception and the pressing of the button to put the plant into operation. In order to look at the economy in such a time-scale, the Soviet Union has twenty-year perspective plans. For more than that length of time, it is difficult to predict. Currently we are operating under a plan that started in 1961 and will end in 1980. Of course, the plan covers not only education but all sectors of the economy. At the end of the twenty-year plan a vacuum has to be avoided; the ideal thing is to achieve certain goals by the end of the period, but about five or six years before the end some projection is made. In 1980, for example, we shall make a balance-sheet of what we planned against what has been achieved, and at that time the new twenty-year plan will be ready.

Secondly, we have the Five-Year Plans, which are more detailed and perhaps more accurate than the twenty-year plans. At the present time we are working through the Eighth Five-Year Plan which started in 1966 and will end in 1970.

Thirdly, as part of the Five-Year Plans we have even more precise annual plans. For example, in the education section, we plan exactly how many students will be admitted into each field of study, how many new schools will be built, where new educational facilities will be located and how graduates shall be distributed, etc. Naturally, such information as this is supplemented by a definite financial plan.

On the education side, a few important financial statistics tell the story of development. In 1940 the total budget of the USSR was 18 million roubles and 2.3 billion went to education, which amounts to about 12 per cent of the budget. The 1946 budget was 32 billion, 3.8 billion going to education, which was slightly less - 11.8 per cent - but the number of children was smaller. By 1960 the budget was 77 billion and 10 billion went to education, i.e. 13 per cent of the budget. And in 1967, out of a budget of 110 billion, 19.7 billion was spent on education, which is 17.9 per cent of the budget.

How is this money divided between the different stages of education ? It is written in the Constitution of the USSR that each child will have a compulsory primary and lower-secondary education (from 7 to 15 years of age). The allocations for those levels of education thus have to be given first. As for secondary technical and all higher education, their expansion is linked to the manpower requirements. The manpower requirements are in turn a function of the projected plans for all sectors (based upon a certain rate of growth) so that the education requirement is a derivative of the total economic plan.

The main authority in charge of general planning is the State Planning Commission headed by the Deputy Prime Minister and responsible to the Central Government. This arrangement gives the Planning Commission more authority than any ministry. In each of the fifteen republics of the Soviet Union there are Republic Planning Commissions. Moreover, in each ministry there is a planning division and there are also planning departments in each branch of industry, in each factory and in certain sub-regions which require their own plans.

The basic statistics needed for planning are worked out by research planning institutions. Advanced mathematical models are used so that 'control figures' can be formulated that scientifically predict development. These figures are distributed to local planners, who are free to comment on them and to propose anything they think would be beneficial.

The broad division of responsibility for educational planning is as follows. Within the framework of the national plans, the individual Republic Planning Commissions are responsible for all local primary and secondary education and this is financed out of local budgets.

For the Soviet educational plan as a whole, proposals are considered in the Ministry of Education, and Ministry of Higher and Secondary Specialized Education. The proposals then go to the State Planning Commission (which gets proposals from all branches of the economy) and it is this Commission that composes the central plan. The plan then goes to Supreme Soviet (Parliament) to be passed into law.

The Soviet Union has a number of higher educational institutions and faculties called Institutes of Economics and Planning which train about 5,000 to 6,000 students as general planners. None of these are trained specifically as educational planners as such but some will eventually specialize in educational planning.

The Ministry of Higher and Secondary Specialized Education is itself responsible for more detailed and accurate outlining of general five-year and twenty-year plans. Some examples are given below:

Students. By 1980 the number of students in higher education is planned to increase to 8 million, as compared to 2,700,000 in 1961 and 4,3 million in 1968. Incidentally, this year (1968) we will be able to admit only about a quarter of the close on 4 million students who will apply for places in higher education. But this intake is geared to the current manpower requirements and every student is guaranteed a job upon graduation.

At present about 55 per cent of students are full-time. By 1980, out of the 8 million, 65 to 70 per cent will be full-time, because the rate of growth of such day students is now much higher than the rate of growth of evening and correspondence students.

In the Soviet Union at the moment there are 786 institutions of higher learning (see Appendix 7). This year we created 3 new universities, but five years from now we could add some 10 or 15 if necessary. Much of the new development is in the east of the country. The Ministry of Higher and Secondary Specialized Education decides just where to build new facilities, where to expand existing institutions, and so on.

The particular problems involved in planning technical education are immense, if only because there are more than 250 fields of training granting different diplomas in engineering. We thus have to plan very accurately the location of new institutions.

For each type of higher education establishment there is an optimum size. For example, we feel that the convenient size of a technical institution should be from 5,000 to 6,000 students, not including part-time and correspondence students, who can be absorbed with little effect on the operation of the institution. This figure is based on various considerations, such as the best use of essential laboratory equipment or an adequate size of department to

organize effective research. Universities, usually located in larger cities and responsible for the culture of the entire areas are much larger. Each division, which is often almost autonomous, can be as large as an independent institution; but the total size of the university should not exceed about 20,000 students.

The most important current problem is to project a plan for the type of training we should give technicians and engineers for the next five or ten years. The projections for needs have to be made at least six or seven years in advance. Thus, we never keep fields of training frozen; when making a 20 year plan we have to foresee that even conventional studies will change and that the methods of teaching will also have to change. We are now trying to cut the amount of special knowledge tied to certain technological processes, because we prefer giving the student a broad knowledge of physics and mathematics that will enable him to devise entirely new methods as well as using his knowledge to adapt himself easily in established situations and to work on further development.

Within the last 8 to 10 years we have changed the content of diploma work. Now, before graduating, every engineering student has to complete a technological project and present it before the Examination Commission, who decides if he can receive his diploma or not. The Examination Commission is composed of Professors of the Institution with a Chairman from outside and some representatives from industry. Some time ago the subject for such a project was given by the departments of the educational institution; nowadays most students get their assignments from industry or from research institutions which provide facilities for the students to work. The result is that the project is now more original and pertinent. Students are now much less tied down by tradition and often present entirely new ideas.

Training of personnel for research institutions.

This is more complicated because, first, research institutions require knowledge in even newer fields than is normally required in industry and, second, such researchers need to have creative ability. Nevertheless, the numbers of scientific researchers in such institutions is growing rapidly; in 1947 there were 143,000; in 1960, 354,000; in 1966, 712,000; at present over 800,000; and in 1980 there will be over 2,500,000.

Training of general teaching personnel.

The long-range planning for providing sufficient teaching personnel is another of the most difficult problems we are facing. One reason for this is because training takes relatively such a great length of time. The ordinary university course and technical education course (for the equivalent of a Master of Science) lasts from 5 1/2 to 6 years, and engineering courses last from 5 to 5 1/2 years. The most able students are admitted to the Ph.D. course which usually takes three years and their research is normally presented to the Board of Scientists which awards the degree. Another way of obtaining the doctorate

is by undertaking the research whilst working. Currently we have just over 100,000 students in Russia studying for doctorates, some of them whilst working.

The Doctor of Science Degree is given only for a very high scientific achievement, by the State Attestation Commission, which is composed of the most distinguished scientists in the country. There are only about 16,000 professors in the country holding D.Scs. and to obtain that degree may take from 5 to 15 years.

As I have already mentioned, we are aiming at doubling the number of students in higher education during the next 12 years. Teaching personnel currently numbers about 320,000 and as we are going to double the number of students, then we will need to at least double the number of teachers. Of these 320,000 about 144,000 (45 per cent) have D.Scs. or Ph.Ds. and we are aiming to keep the same percentage in the future. Our calculations show that from now until 1980, after we have made allowance for the 30 per cent or so of the existing teaching personnel who will retire during the period, we shall need to train over 400,000 new teachers during the next 12 years, including 190,000 D.Scs. and Ph.Ds. As it takes 10 to 15 years to produce these doctorates, this means that those who are going to graduate before 1980 need to have already began their studies. It is the most difficult problem facing us today.

Let me mention just one more feature concerned with planning. With the current very high rate of the development of science, the amount of human knowledge doubles within five or six years. Thus, in order to keep engineers up-to-date we have a system of retraining them; we send them back to institutes every five years for refresher courses. It is a provision of educational institutions that they will retain their graduates. Thus, of about 2 million engineers currently employed in various branches of industry, we have to retrain 400,000 each year and this retraining is normally done on-the-job. The same thing is necessary for teachers and for 4 months every 5 years they are taken away from their work, paid, and sent to a training centre for refresher courses. Language teachers, sometimes are sent on courses abroad.

Some practical considerations in planning technical education in developing countries

Let me first make a couple of general considerations.

The first is that it has been shown that in many developing countries there is a considerable return over a length of time on money invested in education. Of course, it is not possible to get such a return under all conditions; education given to people involved in very primitive types of work will only lead to a very small change in productivity. But a high return on investment is generally possible in industry.

The second consideration is that even in very underdeveloped areas of a country, when a new industry is developed, it must be very up-to-date. Some people say that if a country has nothing and starts to develop its industry, then something is better than nothing, even if it is not up to the level of developed countries. But this, in fact, is the wrong approach because what is important to understand is that present requirements for all types of production in industry are so high that one cannot have different standards of quality between developed and developing countries. Thus, in the Soviet Union, we operate on the principle that when we develop industrial production in developing regions, we must install at least the same quality of industrial plant as in other, more developed parts of the country. In fact it often happens that new plants in developing regions are even more modern than existing plants in the other regions. And the implication of this is that the training of engineers and technicians must be standardized between developed and developing regions so as to avoid the need to import personnel to run the industries.

Now what are the principal ways of accelerating the apread of education ? I refer to 'accelerated' rates because in the Soviet Union before the Revolution it was the opinion that due to specific conditions in some parts of the country (nomadic peoples, natural economy, absence of written language, religious and social restrictions towards education) it would take - according to a prediction published in 1906 - 180 years in some regions to make all males literate and 280 years to make women literate.(1) After the Revolution we were obliged to accelerate the process and solve this problem in a very short time. At the beginning, our problem of spreading education in the Soviet Union was complicated by two factors : First, the lack of educated people who could become teachers; and second the absence of literacy (many areas having no written language, alphabet or books). Thus, apart from creating an alphabet and the written language in these regions, the main task was to develop teacher training. But this problem was actually solved in USSR very quickly.

One of the basic decisions to be made by all developing countries is to map out the broad educational policy when resources for education are limited - which is generally the case. The alternatives are to either give a good, complete education to only part of the population, or to expand education horizontally by universalizing a limited education and afterwards increasing the number of years of schooling. My own view is that the second solution is preferable and this was the choice adopted in the Soviet Union.

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(1) See : 'Role of Education in the Creation of a Modern National Economy : Experience of a Soviet Central Asian Republic and peoples of the Extreme North' by V.Y. Komorov and V.A. Chebotaryov, published by Unesco, 13 March 1967. (WS/0267.18-SHC)

Finally I want to stress the importance of the use of foreign experience and assistance in developing countries for speeding up the development of education. Educationalists in USSR always recommend that when a large industrial grant or loan is given to a developing country, a small portion of the money should be set aside for training people in that field. But how should this (educational) budget be used ? We believe that when foreign teachers are invited or brought into a country, it is a rather limited use of resources if they are put to work themselves in schools. It is far better to use them to train other teachers, or even more advanced, to develop teachers' training centres where the foreign teachers will train local people to teach other teachers. In addition, foreign personnel should not be kept in a country for too long; they should pass on their knowledge quickly to the local people. In these ways the best use is made of foreign know-how to accelerate educational progress in developing countries.

At the same time, teachers from developing countries should be sent for training to more developed countries. Then, after returning home, they will be able, in turn, to train their local colleagues.

When any educational institution is being built in a developing country with aid from foreign sources, it is also necessary to make provision, that after a period of time, all teaching will be carried out by local teachers trained either in the developing country itself, or abroad.

APPENDICES

Appendix I. Number of Pupils at General Secondary Schools in the Union Republics (in thousands)

	1914/1915	1940/1941	1966/1967	Increase in 1966/1967 (times) over 1914/1915	Increase in 1966/1967 (times) over 1940/1941
USSR total	9,656	35,552	48,168	4.9	1.3
RSFSR	5,684	20,633	26.186	4.6	1.2
Ukrainian SSR	2,607	6,830	8,468	3.2	1.2
Byelorussian SSR	489	1,737	1,769	3.6	1
Uzbek SSR	18	1,325	2,592	14.4	1.9
Kazakh SSR	105	1,158	2,865	27.3	2.4
Georgian SSR	157	767	928	6	1.2
Azerbaijan SSR	73	695	1,199	16.4	1.7
Lithuanian SSR	118	380	562	4.7	1.4
Moldavian SSR	92	440	763	8.2	1.7
Latvian SSR	172	242	343	1.9	1.4
Kirghiz SSR	7	334	657	93.8	1.9
Tajik SSR	0.4	315	613	1,532.5	1.9
Armenian SSR	35	333	553	16.2	1.6
Turkmen SSR	7	252	455	65	1.8
Estonian SSR	92	121	215	2.3	1.7

Source: U.S.S.R., Central Statistics Department, USSR in Figures 1966, Moscow, 1967.

Appendix II. Number of Students at Secondary Specialized Schools in the Union Republics

	1914/1915		1940/1941		1966/1967		Increase in 1966/1967 (times) over:	
	thous. of people	per 10,000 people	thous. of people	per 10,000 people	thous. of people	per 10,000 people	1914/1915	1940/1941
USSR total	54.3	4	974.8	50	3,978.8	158	73.2	4
RSFSR	35.4	4	594.0	53	2,408.7	179	68.1	4
Ukrainian SSR	12.5	4	196.2	47	718.7	142	57.4	3.6
Byelorussian SSR	1.4	less than 1	35.0	39	134.8	141	96.2	3.8
Uzbek SSR	0.1	less than 1	25.1	37	122.1	98	1,221	4.8
Kazakh SSR	0.3	less than 1	30.3	48	193.4	140	644.6	6.3
Georgian SSR	0.5	less than 1	26.1	71	43.2	83	86.4	1.6
Azerbaijan SSR	0.5	less than 1	17.4	52	65.0	120	130	3.7
Lithuanian SSR	1.5	5	6.4	22	60.9	193	40.6	9.5
Moldavian SSR	0.5	less than 1	4.1	17	39.8	98	79.6	9.7
Latvian SSR	1.3	5	9.6	50	41.2	169	31.6	4.2
Kirghiz SSR	-	-	6.0	38	35.4	120	-	5.9
Tajik SSR	-	-	5.9	38	27.2	89	-	4.6
Armenian SSR	0.1	less than 1	8.9	66	36.0	143	36	4
Turkmen SSR	-	-	7.7	57	25.3	115	-	3.2
Estonian SSR	0.2	less than 1	2.1	20	27.1	215	135.5	12.9

Source: U.S.S.R., Central Statistics Department, USSR in Figures 1966, Moscow, 1967.

Appendix III. Number of Students in Higher Education

	1914/1915		1940/1941		1966/1967		Increase in 1966/1967 (times) over:	
	thous. of people	per 10,000 people	thous. of people	per 10,000 people	thous. of people	per 10,000 people	1914/1915	1940/1941
USSR total	127.4	8	811.7	41	4,122.5	166	32.3	5.0
RSFSR	86.5	9	478.1	43	2,469.8	186	28.5	5.1
Ukrainian SSR	35.2	10	196.8	47	739.1	152	21.1	3.7
Byelorussian SSR	-	-	21.5	24	115.9	120	-	5.3
Uzbek SSR	-	-	19.1	28	188.4	157	-	9.8
Kazakh SSR	-	-	10.4	16	163.1	119	-	15.6
Georgian SSR	0.3	less than 1	28.5	77	81.4	168	271.3	2.8
Azerbaijan SSR	-	-	14.6	44	78.3	144	-	5.3
Lithuanian SSR	-	-	6.0	20	50.7	155	-	8.5
Moldavian SSR	-	-	2.5	10	40.6	108	-	16.2
Latvian SSR	2.1	8	9.9	52	35.9	146	17.1	3.6
Kirghiz SSR	-	-	3.1	19	36.7	122	-	11.8
Tajik SSR	-	-	2.3	15	34.7	118	-	15:1
Armenian SSR	-	-	11.1	82	43.3	177	-	3.9
Turkmen SSR	-	-	3.0	22	22.7	104	-	7.5
Estonian SSR	3.3	35	4.8	45	21.9	166	6.6	4.5

Source: U.S.S.R., Central Statistics Department, USSR in Figures 1966, Moscow, 1967.

Appendix IV. Number of Students being Trained as Engineers and Technicians in the Union Republics (in thousands)

	1941		1964		Increase in 1964 (times) over 1941	
	Engineers	Technicians	Engineers	Technicians	Engineers	Technicians
USSR total	289.9	320.1	1,325.1	2,292.7	4.6	7.2
RSFSR	187.7	211.6	871.5	1,539.4	4.6	7.5
Ukrainian SSR	60.9	58.5	247.0	411.9	4.0	7.1
Byelorussian SSR	4.9	9.6	27.0	56.3	5.5	5.1
Uzbek SSR	5.3	6.0	25.3	46.3	4.9	7.6
Kazakh SSR	4.2	7.2	40.1	82.2	9.5	11.5
Georgian SSR	7.8	5.4	29.8	20.4	3.7	3.8
Azerbaijan SSR	6.5	5.1	19.6	24.0	3.0	4.8
Lithuanian SSR	2.4	2.9	11.2	16.6	4.5	5.6
Moldavian SSR	0.8	0.9	6.5	12.6	8.0	14.0
Latvian SSR	3.4	4.4	12.7	23.6	3.8	5.4
Kirgiz SSR	0.8	1.2	6.2	13.3	7.8	11.0
Tajik SSR	0.7	1.0	4.8	9.3	6.9	9.3
Armenian SSR	1.4	1.6	11.8	11.3	8.4	7.0
Turkmen SSR	1.3	2.2	4.1	11.2	3.1	5.0
Estonian SSR	1.8	2.5	7.4	14.3	4.1	5.7

Source: U.S.S.R., Central Statistics Department, USSR in Figures 1966, Moscow, 1967.

Appendix V. Some Data on Economic Development in the USSR
(in percentage of 1913)

	1913	1917	1940	1945	1960	1967
Gross national income	100	75	535	445	2,327	3,658
Gross production :						
industrial	100	71	769	705	4,032	7,096
agricultural	100	88	141	86	224	288
Capital investments	100	-	555	523	3,665	5,964
Total labour force	100	-	263	221	481	643
Labour productivity (efficiency) :						
in industry	100	-	376	427	1,113	1,540
in agriculture	100	86	193	131	347	439
Total capacity of electric power plants	100	100	1,020	1,012	6,120	11,250
Annual production of :						
electric energy	100	95	2,420	2,160	14,165	27,320
crude oil	100	-	305	193	1,465	2,840
natural gas	100	-	1,020	1,050	15,100	52,650
coal	100	-	573	512	1,722	2,036
steel	100	71	431	285	1,378	2,395
machine tools	100	130	3,000	3,800	26,800	58,800

Source: U.S.S.R., Central Statistics Department, USSR in Figures 1967, Moscow, 1968

Appendix VI. Some Data on Cultural Development in the USSR
(in percentage of 1913)

	1913	1940	1960	1967
Number of specialists employed :				
in higher education	100	672	2,620	3,870
in specialized college education	100	276	971	1,280
Number of : medical doctors	100	551	1,540	2,060
places in hospitals	100	398	869	1,160
Number of children in Kindergarten	100	42,900	97,200	181,000
Number of books published (copies)	100	465	298	1,260
Number of newspapers published (copies)	100	232	62.4	1,842
Number of books published in some national languages :				
Ukrainian	100	-	-	1,321
Byelorussian	100	-	-	16,800
Uzbek	100	-	-	2,150
Kazak	100	-	-	1,460
Azerbaijan	100	-	-	1,165
Georgian	100	-	-	804
Armenian	100	-	-	329

Appendix VII. Higher and Secondary Specialized Education in the USSR

	1913	1940	1945	1960	1967	1968
Higher Education:						
Number of establishments	105	817	789	739	767	785
Number of students (thousands)	127.4	811.7	730	2,396	4,122.5	4,311
Among them taking courses:						
full-time	127.4	558	525	1,156	1,740	1,887
part-time	-	27	14	245	618	654
by correspondence	-	226.7	191	995	1,764.5	1,770
Secondary Specialized Education (colleges)						
Number of establishments	450	377.3	3,169	3,328	3,980	4,074
Number of students (thousands)	54.3	974.8	1,008	2,060	3,978.8	4,166
Among them taking courses:						
full-time	54.3	787	886	1,091	2,111	2,249
part-time	-	32	21	370	677	716
by correspondence	-	155.8	101	599	1,200.8	1,233

Source: U.S.S.R., Central Statistics Department, USSR in Figures 1966, Moscow, 1967.