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ABSTRACT

This paper describes the changes in the science and mathematics curriculum in Soviet classrooms since the 1984 reforms and the "glasnostic" climate. The first section discusses the trends in Soviet education including the humanist, national, moral and materialistic trends. The second section examines variations in the science curriculum since the late 19th century. The third section reviews several studies observing the changes in Russian/Soviet schools. Reactions to education representing the materialistic trend with a moral and humanistic face in the mid-1980s are cited. Reactions to the changes in the science curriculum, including biology, physics, and chemistry, and the mathematics curriculum are summarized in the next two sections. Finally, some implications for American education are discussed. There are 28 references listed. (YP)

SHAPING SCIENCE AND MATH CURRICULUM IN THE AGE OF GLASNOST: REPORTS FROM SOVIET CLASSROOMS

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ABSTRACT

How has science and math curriculum in Soviet classrooms been affected by the 1984 Reforms, the Second Stage Reforms, and the "glasnostic" climate? Descriptions of these curriculum changes and the reactions they generated from Soviet teachers and academicians (reviewed in such sources as Soviet Education) are synthesized within recurrent "traditions" discussed by Hans (1963). These reforms are also viewed within the light of changes in Soviet educational philosophy and in national demographic patterns and economics.

Are there trends in the evolution of education in the Soviet Union? How did the emphases on the education of the human, citizen, scientist, and worker vary in the last century in the Soviet Union? What seems to be the evolving emphases toward science in education during this "glasnostic" period? What societal factors might influence the direction of the educational system at this particular moment in Soviet history?

Trends in Soviet Education

Hans (1963) identifies four trends in the Russian tradition in Education -- the Humanist, National, Moral, and Materialistic trends. These trends, major themes in the educational history of Russia/the Soviet Union, might be useful to serve as metaphors for tensions currently within the Educational Reforms in the Soviet Union. Attitudes towards the role of science in education within these trends are also examined for their implications on current curriculum reform.

The Humanist Trend

Hans first links the Humanist trend to N. I. Pirogov, a medical doctor and educator, who during the mid-nineteenth century, wrote of the importance of preparing the learner "to be a man", of developing "a humane, Christian and modern European charcater in the soul of the pupil." For Pirogov, "the main thing in the education of children consists not in what they learn, but in how it is learned....The most ordinary and daily subjects, well and skilfully taught to the child, are at hundred time more useful to it in the future than the highest truths badly expressed and not adapted to childish conceptions."

V. G. Belinsky, a contemporary of Pirogov, also warned of the need to recognize the unique nature of the individual learner. He suggested that "training should assist nature, but nothing more. Contemporary teachers neglect the nature which endows the child with particular abilities and inclinations....The soul of the infant is not a tabula rasa, but a plant in germ, a human being in his potentialities."

N. G. Chernyshevsky, also in the mid-ninteenth century, occurred that education should be gentle. He wrote that "for the training of children no compulsion is necessary, only the benevolent guidance of children; do not prevent your pupils from growing up to be clever and honest men - that is the fundamental demand of the contemporary theory of education...The compulsive power of adults over children

should be limited to preventing them from harming themselves or others."

At the turn of the twentieth century, a political activist, P. F. Lesgaft continued in this humanist trend. He wrote that "the task of the school is not to secure the acquisition of knowledge, but to assist in the development of abstract thought and the formation in the mind of a notion of human personality and inviolability."

M. I. Kalinin, a Soviet educational philosopher of the mid-twentieth century, also reflected this student-centered concept of education. Kalinin defined education as the "means to influence the psychological and moral development of a youngster, namely, to make a man out of him. The example set by the teacher and his relationship to students is the main method of teaching."

The Humanist trend is also characterized by an emphasis on the humanities and universal values. N.I. Pirogov wrote that "the ideal normal situation of education in society would be all without exception to enter life by the highway of a university....For the rational organization of schools we have to choose between the establishment of two ways of education, one general education, while the other would follow a purely academic course, preparing exclusively for the university."

As a theme in Soviet education, the philosophers of the Humanist trend additionally stressed the dominance of the

individual and his/her personal development over subject matter. A.S. Makarenko, considered by Hans to be the greatest representative of communist education and a scholar of the revolutionary period up to the late 1930s, summed up one of the themes of the Humanist trend by stating that "the aim of education is the fulness of human personality of the human character."

Makarenko also represents a tendency in the Humanist trend to distrust science and the influence of university "pedologists" on education. He wrote that "pedagogy, especially the theory of upbringing, is geared primarily toward a practical goal, that of a clearly defined political aim which derives from our social needs and strivings. Naturally, its formulation can stem neither from biology nor from psychology. Only when the two sciences can precisely describe the development of personality and behavior will we be able to lean more upon their findings."

As described by Hans (1963), the Humanist trend may be characterized by its stress on the education of the self-actualized individual, university and universal training, and a distrust of reliance on science in determining and implementing educational goals. These characteristics contrast strongly with the following trends.

The National Trend

The goals of diffusing education to the masses, disseminating ideas, and developing a new civic culture

characterize the National Trend, acccording to Hans. K. D. Ushinsky, a nineteenth century scholar and official of the Ministry of Public Instruction, is considered by Hans to typify philosophers of the National Trend.

Ushinsky is also viewed as a both a champion of Russian Nationalism and a pioneer of Comparative Education. His educational postulates rests on both these national and universal perspectives -- "(1) There is no system of education suitable for all nations. (2) Every country has its own particular tradition. (3) The experience of other nations in education is a precious heritage for all in the same sense as the experience of universal history. (4) Science should not be confused with education, it is common to all peoples. (5) Public education does not solve the problems of life and does not lead history, but follows it. (6) Public education is efficient only when its problems become the problems of society and the family. (7) The only safe foundation for reform of education is the public opinion of the nation."

These statements illustrate two of Ushinsky's themes -- the reliance of education on both the particular conditions of the nation and the universality of science. He wrote that "any fundamental and positive opinion in the work of public education should be based on two principles: 1) the actual needs of the society which has to educated, and 2) the results of science, common to all peoples." He

continued that "science accepts only those conclusions which are justified by the laws of thought common to all men....Science, which discovers the laws of the universe, is like the universe and reasoning power, the property of the whole human race."

The National trend, as represented by Ushinsky, rested on confidence in the general progress of humanity, reliance on science as the means for development, and belief in the uniqueness of the Russian people. In the National trend, the stress on education is less on the individual and more on the conditions of the nation. Science is the foundation of education and transcends nationalism.

Moral Trend

Hans selects L. N. Tolstoy, the author War and Peace, to represent the Moral trend. Education for these philosophers was an active force to change society by changing individuals. Tolstoy wrote in the 1860s that "only when experience becomes the foundation of the school, only when every school is an educational laboratory, only then will the school not lag behind general progress and experience be able to lay a firm foundation for the theory of education." Tolstoy considered that "the need for education is innate in every human being. People love and seek education as they love and seek air to breathe."

Science also played an important role in the Moral perspective on education. Tolstoy wrote that "the

educative element in science cannot be transferred to the pupil by force... If you want to influence your pupil by science, then love your subject and know it, then the pupils will love you and science and you will influence them. But if you do not love your subject, all your efforts will be futile and science will not train." Successful science instruction should have clear life applications and be delivered with a great deal of enthusiasm.

N.A. Dobrolyubov, another nineteenth century philosopher, warned that scientific reasoning alone was not sufficient for effective education. We wrote that "we desire reasoning to dominate education, but this reasoning should be known not only to the teacher, but should be presented clearly to the child as well.... We demand that the teachers should show more respect to the dignity of human nature and should strive to develop and not to suppress the inner man in their pupils. The teacher should strive to produce a man who is moral, not from habit alone, but from conscientious conviction."

N. K. Krupskaya, considered to be the major educational philosopher of the revolutionary period, echoed many of the themes in Tolstoy's writing also. Krupskaya predicted that "education will remain a class privilege of the bourgeoisie until the aims of the school are changed. The population is interested in having a single aim in primary, secondary and higher education: that is, the training of many-sided

men with conscious and organized social instincts, having a well-elaborated, consistent ideology. They should clearly understand the natural and social life around them. They should be ready for any work, manual or intellectual. They should be able to build a rational, beautiful, joyful social life."

The Moral trend, as identified with the writings of Tolstoy, Dobrolyubov, and Krupskaya, eschewed the classical, universal education of the Humanist trend; shared confidence in the Russian people and in science with the National trend; and supported the stress on experiential education in common with the Materialistic trend. Yet, for the Moral philosophers, education and work were not as deeply interconnected as they were for those scholars of the Materialistic trend.

The Materialistic Trend

Hans identifies the Materialistic trend with the major educational philosophers of the early revolutionary period. V.L. Lenin's thoughts on education represent the perspective shared by many Soviet educators. Lenin wrote that "all education should be arranged in such a way that in each day time should be found for the youth to solve a practical problem of common significance, no matter how small and simple the task might be....Without work or struggle, theoretical knowledge...is absolutely meaningless, since it continues to perpetuate the isolation of theory from

practice...Children and youth must realize that their work brings real gain to their family or city, town or village."

The Materialistic trend stresses the interconnectiv ness between education and work. In the late 1950s, Premier N.S. Khrushchev proclaimed that "the most important task of education is that all children sould be ready for useful work...The only possible and necessary condition for surmounting the defects of our schools is to prepare all young people, while they are in school, for manual work in factories, farms, in any labor useful for society." A contemporary educator, E. Krechetova, agreed that the school curriculum's main purpose is "to strengthen the ties between school and life which means to develop in youngsters not only academic skills but also ability and proper attitudes toward labor. They must consider work as a primary life necessity and receive genuine vocational preparation."

There seems to be a continuum from student-centered education to teacher-directed curriculum, from the Humanist through the Materialistic trends. For the Materialistic trend philosophers, such as G. S. Prozorov, "education means a system of organized, purposeful influences to which the child is exposed by parents at home, teachers in school, and other educators in extracurricular groups....One must actively help the child's development through a purposeful education rather than be depending on his native, inherited

abilities." The Materialistic trend emphasizes the linkages between education and work and envisions the school as a purposeful social change agent.

As outlined in this discussion of the four trends, Russian/Soviet educational philosophy has changed over time. The interaction between the learner and the subject matter, the locus of control of the learning, and the educational objectives of school have varied over time. An examination of how educational curriculum, particularly science education, has varied over the same period follows in the next section.

Curriculum Changes Reflecting the Trends

In the above discussion, the Humanist, National, Moral, and Materialistic trends were reviewed through selected statements by educational philosophers. Hans suggests that these trends might have influenced the curriculum taught in Russian/Soviet schools. TABLE 1 illustrates the number of hours and percentages of total time that was scheduled for specific subjects in 1871, 1915, 1959, and 1988. There seems to be significant differences between how the curriculum was defined during these three years. Certainly, after the revolution, religion was no longer taught in schools. Latin and Greek instruction was also not in fashion in the twentieth century. Practical work also played a much larger role in schools in 1959.

TABLE 1.

CURRICULUM TIME ALLOCATIONS IN RUSSIAN/SOVIET SCHOOLS
1871, 1915, 1959, 1988
No. of hours/periods per week
throughout 8 years 11 years

Subjects	adapted from Hans 1871 hr/wk	%	1915 hr/wk	%	1959 hr/wk	%	from Muckle 1988 per/wk.	%
Religion	13	6%	14	7%	--	--	--	--
Russian/1st lang.	24	12%	34	18%	45	17%	81	27%
Latin & Greek	85	41%	--	--	--	--	--	--
Mathematics,							60.5	20%
Physics and	37	18%	57	30%	72	27%	25	8%
Natural Sciences							13.5	4%
Geography	10	5%	16	9%	12	5%	10.5	3%
History	12	6%	17	9%	22	8%	24.5	8%
Modern Languages	19	9%	13	7%	20	8%	14	4%
Logics-Computers	1	1%	2	1%	--	--	3	1%
Drawing-Writing	5	2%	7	4%	8	3%	10	3%
Physical Culture	--	--	21	11%	16	6%	26	9%
Singing	--	--	3	2%	5	2%	8	3%
Practical Work	--	--	3	2%	64	24%	28	9%
TOTAL HOURS/WEEK	206		187		264		304 periods	

information on 1871, 1915, and 1959 --
adapted from Hans, N.A. THE RUSSIAN TRADITION IN EDUCATION, pg. 157.

information on 1988 adapted from Muckle, J. A GUIDE TO THE SOVIET CURRICULUM, 1988, pg. 19.

TABLE 2.

ANALYSIS OF ABOVE CURRICULM BY EDUCATIONAL FOCI

ED'L. FOCI	1871 hr/wk	%	1915 hr/wk	%	1959 hr/wk	%	1988 per/wk	%
HUMANIST	122	59%	37	20%	33	13%	32	11%
CITIZEN	46	22%	67	36%	79	30%	116	38%
SCIENTIST	38	18%	59	32%	72	27%	102	34%
WORKER	--	--	24	13%	80	30%	54	18%
TOTAL HOURS/WEEK	206		187		234		304	
AVERAGE PER YEAR	26		23		33		28	

CORRESPONDING GROUPING OF COURSES IN CURRICULUM BY ED'L. FOCI

HUMANIST - Religion, Latin & Greek, Modern Languages, Drawing, Singing

CITIZENship - Russian, Geography, History

SCIENTIST - Mathematics, Physics, Natural Sciences, Computers, Logic

WORKER - Physical Culture and Practical Work

These curriculum changes were further analyzed in TABLE 2 by dividing the courses into four groups: 1) Humanities - defined as Religion, Modern Languages (other than Russian or another first native language, Drawing, and Singing; 2) Citizenship - Russian or another native first language, Geography, and History; 3) Sciences - Natural and Physical, Mathematics, Computers, and Logic; 4) Physical culture and practical work. These four groupings were designed to parallel Hans's trends and possible educational foci for curriculum. The first group is indicated in TABLE 2 as HUMANist and represents the Humanist trend. CITIZENship parallels the National trend. SCIENTIST reflects the Moral trend, particularly the influence of Ushinsky. WORKER parallels the Materialistic trend.

The Czarist school of 1871 seems to have stressed the HUMANIST over the other foci. The emphasis of the war-time school of 1915 was on the CITIZEN and the SCIENTIST. The WORKER, CITIZEN, and SCIENTIST shared prominence in the curriculum of 1959, while the WORKER is in decline in 1988 with the CITIZEN and SCIENTIST sharing the majority of the curriculum time.

It should be noted from Figure 1 that Muckle (1988) estimates the total number of periods per week for the 11 grades of the curriculum at 303 periods. Estimating the school year at 42 weeks per year, the Soviet student attends 12,726 periods in 11 years (about 1156 periods per year, or

Figure 1

Model Curriculum for the General Education School

from Mucille, James. A Guide to the Soviet Curriculum: What the Russian Child is Taught in School. London: Croom Helm, 1988, pg. 19.

Figure 1 Model curriculum for the general education school.

	Periods per week per class											
	Primary						Secondary					
	1	2	3	4	5	6	7	8	9	10	11	Total
First language and literature	7	9	11	11	11	9	6	5	5	4	3	81
Mathematics	4	6	6	6	6	6	6	6	6	4/5	4	60.5
Principles of Information Science and Computer Technology	-	-	-	-	-	-	-	-	-	1	2	3
History	-	-	-	-	2	2	2	2	3	4	3	18
Principles of Soviet State and Law	-	-	-	-	-	-	-	-	1	-	-	1
Social Studies	-	-	-	-	-	-	-	-	-	0/2	2/1	2.5
Ethics and Psychology of Family Life	-	-	-	-	-	-	-	-	0/1	1/0	-	1
Acquaintance with the World Around	1	1	-	-	-	-	-	-	-	-	-	2
Nature Study	-	-	1	1	1	-	-	-	-	-	-	3
Geography	-	-	-	-	-	2	3	2	2	2/1	-	10.5
Biology	-	-	-	-	-	2	2	2	2	1	1/2	10.5
Physics	-	-	-	-	-	-	2	2	3	4/3	4	14.5
Astronomy	-	-	-	-	-	-	-	-	-	-	1	1
Chemistry	-	-	-	-	-	-	-	3	3/2	2	2	9.5
Technical Drawing	-	-	-	-	-	-	1	1	-	-	-	2
Foreign Language	-	-	-	-	4	3	2	2	1	1	1	14
Art	2	1	1	1	1	1	1	-	-	-	-	8
Music	2	1	1	1	1	1	1	-	-	-	-	8
Physical Culture	2	2	2	2	2	2	2	2	2	2	2	22
Elementary Military Training (NUP)	-	-	-	-	-	-	-	-	-	2	2	4
Labour and Vocational Training	2	2	2	2	2	2	2	3	3	4	4	28
TOTAL	20	22	24	24	30	30	30	30	31	31	31	303
Options	-	-	-	-	-	-	2	2	2	3	4	13
Socially-useful Productive Labour	-	1	1	1	2	2	2	3	3	4	4	23
Labour Practice (in days)	-	-	-	-	10	10	10	16	16	20	-	-

192 days per year at 6 periods per day). Muckle also reports that Socially-useful Productive Labor and Labor Practice are extramural activities expected of students outside of the formal school setting. Considered as part of a global educational experience, the extramural time allocation for Labor would equal 82 days over 11 years (estimated at 492 periods at 6 periods per day) and for Socially-useful Productive Labor 966 periods (23 periods per week by 42 weeks per year). The total periods for out-of-school labor may be calculated as 1458 periods. The total educational experience for extramural labor would represent about 10% of the combined general education and extramural time allocation, a total in eleven years of 14,184 periods, an average of 31 periods per week each year. Even including the 1176 periods for Labor and Vocational Training within the 11 year curriculum, all forms of intra- and extramural Labor represents only 19% of the total formal and nonformal educational experience of a student. Following the definition of the WORKER foci in TABLE 2, including Physical Culture with this Labor option would bring the percentage for this WORKER foci to 26%. This percentage is between the stress in Practical Work in 1959 of 24% and WORKER foci then of 30% and the relative de-emphasis in the formal curriculum of Practical Work in 1988 of 9% and total formal educational allocation of 18%.

These trends in the changing emphases of the curriculum are also reflected by observations of Russian/Soviet schools and reactions to the curriculum over the last 120 years. These observations are reviewed in the following section.

OBSERVATIONS WITHIN RUSSIAN/SOVIET SCHOOLS

Nearly thirty years ago, a generation and more ago, members of the Comparative and International Education Society prepared a field study on The Changing Soviet School. Bereday, Brickman, Read, and Schlesinger (1960) found that education in the U.S.S.R. "is used as a tool to further the realization of Soviet goals, whatever they may be." They quote Lenin as observing that "without teaching there is no knowledge; without knowledge there is no communism." They felt that that the spirit and purpose of education in the Soviet Union is so contrary to the objectives "our people and nation have for schools and colleges' as to make comparisons with the eudcational process in the United States difficult if not meaningless" (pg. viii).

According to these authors, culture reached a high point in the era around the Czarist school of 1871. Foreign influence in education was evident at the time. Bereday et. al. (1960) cite Florinsky as noting that "science in Russia, like art (and in a smaller degree music), stemmed from a foreign tradition and was somewhat akin to a luxurious flower blossoming on the surface of a stagnant

pool of ignorance and illiteracy" (pg. 44). The authors do note that manual training in Russia was admired by educators in the United States, although they add that "Russian technical instruction was derived from principles and practice of Scandinavian and Swiss origin" (pg. 44). According to Hans (1963) though, Practical Work was not part of the curriculum in the school of 1871.

By 1915, secondary-school attendance had increased greatly. The classical emphasis was curtailed and "Greek had practically disappeared by 1914" (pg. 48). The schools of 1915 were characterized by student unrest and increased attendance by students from all classes.

By 1959, Bereday et. al. (1960) describe a eleven-year educational program, with seven-year schools being universal and compulsory throughout the Soviet Union, with plans to increase to at least compulsory ten-year programs. One of the emphasis on the educational system at the time was preparation for work. Bereday et. al. (1960) cite a deputy minister of education as noting that "only 20 per cent of the graduates of the ten-year school can be admitted to universities today. The others must go to work from school (pg. 189)." A student was quoted as saying that he spent half his time in school and half in a nearby factory.

This tension between the ideals of universal education and the perception that not all students might succeed was evident in these writers' observations of Soviet math and

science classes in 1958. It was noted that the unknown quantity in mathematics was introduced as early as fourth grade, math instructors made use of a large number of visual aids but there was little small group instruction, and that the teaching of geometry stressed measurement and plane geometry rather than solving formal proofs.

The sciences were not confined to a single grade; instruction started in the last elementary grades and extended into high school. The observers found that the significance of science for the economy was stressed. Instruction tended to be teacher-centered with frequent use of lecturing. Biology teaching aids and class sets of microscopes were available in several classes visited. The content of chemistry and physics course were found to be more rigorous than in American schools at the time, with an emphasis placed on the basic laws and the mathematical approach.

Bereday et. al. (1960) found that one of the most interesting and meaningful phenomena in the Soviet education of the late 1950s was the reintroduction of polytechnical education. The Soviet aims for polytechnical training were "to acquaint children with the most important branches of modern industrial and agricultural production, to impart skills inhandling a great variety of materials and tools, and to develop related labor skills and endurance" (pg. 242). The authors quote Khrushchev as declaring that "the

chief and root defect of our secondary and higher schools is the fact that the are divorced from life (pg. 247)."

The school of 1959 might be characterized by these observations as being more orientated to work, practice and less on theory. A Soviet scholar at the time noted that "the person who is inclined to be intellectual must understand the process of work and the worker as a person" (pg. 249). This stress on work differs from the classical emphasis in the Czarist school or the social unrest of the school of 1915.

REACTIONS TO EDUCATION IN THE MID-1980S

Following the "Fundamental Directions of General Education and Vocational School Reform" published by the Minister of Education, Konstantin U. Chernenko, in 1984, a renewed interest in education arose in the national discussion on societal reform. Klement'ev (1984), an Associate Professor at the Moscow Engineering and Physics Institute, reflects a general view of education as focused on both the role of socialization and vocationalization. Klement'ev wrote that "contemporary research has confirmed the structural-functional approach to general issues in education...Education is an increasingly significant form of regulative and goal-oriented socialization and vocationalization for individuals, which serves to prepare them for the fulfillment of their existent social roles and thereby makes a unique contribution to the functioning of

social structures and institutions and to social reproduction over time."

Lesokhina (1984), a Senior Research Associate at the USSR Academy of Pedagogical Sciences' Scientific Research Institute of General Adult Education, also stresses the role of education as "an important factor in social progress: being a universal instrumentality for the transfer of social and cultural experience, a unique 'translator' of the demands that society makes on the individual, it is also necessarily present in absolutely everything a person does." Lesokhina continues that "education plays a 'liberating' role in the system of social regulation and self-regulation of conduct in the individual personality."

Slutskii (1984), a Professor and Department Head at the All-Union Correspondence Polytechnical Institute, continues with this stress on the individual's role in education and in vocationalism by stating that "... the fundamental nature of education is the decisive proviso of flexibility, of untrammelled transition from one type of activity to another, of the actualization of the creative approach to the solution of complex occupational tasks."

In a review of polytechnical education, Atutov (1983), Director of the USSR Academy of Pedagogical Sceinces' Scientific Research Institute of Labor Training and Occupational Guidance, also emphasizes the importance of work in education within a context of individual

development. Atutov states that "polytechnical education equips pupils with knowledge that will ensure an assimilation of the generically scientific foundations and the unified organizational and economic principles of contemporary production." Atutov also finds that "the revised academic curricula for the scientific basics and labor instruction, which point up with greater emphasis the foundations of technical procedures and technology and offer a broader and deeper demonstration of the emotional impact of the work done by Soviet people."

Razumovskii (1986), Academic Secretary to the USSR Academy of Pedogogical Sciences' Division of Didactics and Teaching Methods, continues with this theme of education for social and individual development. Razumovskii lists the tasks that were set "when development work was undertaken on the new content of general polytechnical education: to enhance the scientific level of academic subjects in line with the requirements generated by the acceleration of scientific and technological progress; to strengthen their role in shaping a scientific worldview; and to embed into the new curricula the conditions needed to achieve profound pupil knowledge and to equip pupils with the necessary practical skills."

The above authors, writing in the mid-1980s, seem to echo the Materialistic Trend outlined by Hans (1963) with undertones of both the Moral Trend and the Humanistic Trend.

Stress is placed on education to prepare the student for a vocation but statements on education including "shaping a scientific worldview", recognition of the "emotional impact of work done by the Soviet people", "actualization of the creative approach to the solution of complex occupational tasks", and education playing "a 'liberating' role in the system of social regulation and self-regulation of conduct in the individual personality". These writers seem to suggest that Soviet education in the mid-1980s represents the Materialistic Trend with a Moral and Humanistic Face. There seems to be little discussion of education for national defense or the uniqueness of the Soviet people that is common to the Nationalist Trend.

REACTIONS TO CHANGES IN THE SCIENCE CURRICULUM

Following the educational reform of the mid-1980s, there was a great deal of discussion about changes in the science and math curriculum. In a review of the 11 year school program, Muckle (1988) finds that since 1981 both biology and physics have lost a lesson per week for one year, chemistry has lost half a lesson, and astronomy keeps its one period. Currently, in the model curriculum for the general education school, there is one period a week in "Acquaintance with the World Around" in grades 1 and 2, one period a week of "Nature Study" in grades 3, 4, and 5. For Biology, there are two periods a week in grades 6 through 9, one period in grade 10, and one-half period in grade 11.

For Physics, there are two periods in grades 7 and 8, three in grade 9, 3 or 4 in grade 10, and 4 in grade 11. In Chemistry, there are three periods in grade 8, two or three in grade 9, and two periods per week in grades 10 and 11. Astronomy is studied for one period per week in grade 11.

Besides these changes in the quantity of the Science courses, there have been qualitative changes that have been discussed by teachers throughout the Soviet Union. The sciences are reviewed by disciplines in the following sections.

Reactions to the New Biology The reforms in Biology were viewed by Gudoshnikov et. al., in the Department of Biology Teaching at the Lenin Komosol State Pedagogical Institute in Tomsk in 1986, as strengthening the "continuity between the course topics and sections, by dint of a more consistent study and development of cytological, evolutionary, and ecological concepts." They note there has been a movement in "the direction of stronger interdisciplinary links between biology and other academic subjects (especially chemistry)". The science curriculum also reflects "the basic directions of development in scientific and technological progress and the contemporary achievements of science, technology, and culture. It has a stronger practical tenor" with "increased attention accorded to issues pertaining to the economics and intensification of

the economy during the study of all sections, especially those in general biology."

They find "certain negative aspects and omissions" including the "substantial abridgment of the essential topcis concerning the emergence of life on earth." "While the tendency to strengthen the practical tenor of biology instruction by the increasing the number of displays, laboratory projects, and practical projects is a positive one, not all the curriculum's suggestions along these lines can realistically be implemented in schools." Biology teachers in the Minsk's Moskovskii District schools agree that, "a whole array of issues in the new curriculum will occasion difficulties for teachers seeking to acquire competence in it, since no methodological elaborations on the curriculum have as yet been produced." These teachers feel that the overwhelming majority of schools may lack the necessary instructional materials for the science curriculum.

Other teachers find that on technical grounds that the revised curriculum may need revision. One teacher in Iaroslavl' comments that there is no mention of the viewpoint that holds that bacteria and blue-green algae form a single organismic kingdom. Another in Kirov argues for the 1983 curriculum to be revised to stress more ecological interconnections.

The biology teachers in the Arkhangel'sk Region suggest that the curriculum include more details on the requirements with respect to pupil knowledge and skills and that some laboratory projects be converted to demonstration projects given the unavailability of materials for distribution. The expedited publication of textbooks with appendices containing all the materials needed and information on teaching methods and provision for dividing a 25-30 pupil class into subgroup for laboratory projects and field trips were also suggested.

Shashkov et. al. (1986) suggest that biology has been placed at a disadvantage in comparison with the other subject disciplines in time allocation. They applaud the new steps taken to bring biology and labor instruction closer together and suggest that additional studies of the local environment should be included in the study of the natural world.

Reactions to the New Physics Razumovskii (1986) describes the new physics curriculum as being divided into two stages. In grades 7 and 8, students will study the types of matter, physical phenomena, basic physical concepts, and certain laws. In the second stage (grades 9 through 11), students will follow a methodical course of study in mechanics, molecular physics, the fundamental of thermodynamics, electrodynamcis, and quantum physics. By generalizing the role of fundamental theories, the number of

topics studied have been reduced and some material (such as geometrical optics) is introduced in an earlier grade by improving interdisciplinary links. Razumovskii suggests that this connection between theory, practice, and mathematics makes it possible "to tackle in a more thorough-going manner the tasks involved in shaping the pupils' scientific world-view."

Razumovskii adds that the "new astronomy curriculum has a stronger astrophysical component, including a study of astronomical research methods.

Reactions to the New Chemistry Chemistry is also linked with the physics course. Inorganic chemistry is studied in grades eight and nine, organic chemistry in grades ten and eleven. Razumovskii reports that within the new curriculum individual pupil activity has increased through laboratory projects and practical problem-solving activities, Mendeleev's fundamental theory of the periodic system has been incorporated more organically throughout the structure of the course, and that applied chemistry and chemical production is the focus of grade 11. Kuramshin (1986) criticizes this transfer of the curriculum's generalizing propositions to grade 11, the emphasis on organic chemistry, and the new curriculum's reliance on the content of the former curriculum without adding original conceptions. Lagunova (1986) reports that teachers view the doubling of the number of hours for the generalization of the entire

chemistry courses are a positive characteristics of the new curriculm.

REACTIONS TO CHANGES IN THE MATH CURRICULUM

Muckle (1988) reports that mathematics has lost overall one lesson since 1981, although mathematics is still second only to first language and literature in time allocation to a curricular topic. The amount of mathematics studied by Soviet students exceeds the amount of Biology, Chemistry, Physics, and Astronomy combined (60.5 total periods per week over 11 years vs. a combined Science total of 35.5 periods per week).

Razumovskii (1986) reports that at the present time, the school mathematics course falls into four parts: Mathematics (grades five and six); Algebra and Geometry (grades seven through nine); and Algebra and Beginning Analysis and Geometry (grades ten and eleven). He suggests that the new mathematics curriculum has overcome the shortcomings of the mathematics education of the 1970s by eliminating excessive instructional formalism, deemphasizing the fast pace of the course, enhancing the applied and practical tenor of instruction, improving the methodological system for subject instruction, and identifying the content through agreement with the USSR Academy of Sciences' Dvision of Mathematics.

Muckle (1988) notes that the first priority of mathematics in the primary grades is developing skills of calculation reflecting real-life situations. Secondary

mathematics falls into two division -- grades 5 through 9 conver basic mathematical information, while the last two years move into differential and integral calculus and advanced solid geometry. Geometry and algebra in the middle years are taught as a "separate but connected" course.

IMPLICATIONS OF THE EDUCATIONAL REFORM IN THE USSR

Szekely (1987) suggests that "any analysis of educational reform in the USSR makes clear the fact that in any large country, whether one is talking about a decentralized education system like that of the United States or a centralized one like that of the Soviets, there are great problems in the educational reform process." Science and math curriculum in the Soviet Union has been revised in the last 5 years towards a more polytechnic approach that includes greater integration of the sciences, an emphasis on "hands-on" activities, and an abridgment of the more theoretical aspects of science like evolution. The problems posed by the curriculum revisions of the mid-1980s include the shortage of instructional supplies to support laboratories, the lack of appropriate text materials and detailed curriculum, and the need for more specific requirements for student skills.

Science curriculum reform in the Soviet Union is beginning to have an influence on conversations among science educators on curriculum change in the United States.

Aldridge (1989) suggests that science education in the United States should be revised to follow the curricular models of the Soviet Union and the People's Republic of China. Aldridge writes that "in both countries, all - yes, all - students take several years of biology, chemistry, and physics." TABLE 3 illustrates the differences in time allocation for science instruction in these three nations.

Most studies in education usually lead to further avenues of research. This study has suggested that curricular emphases have changed over time in the Soviet Union. Are there any corresponding changes within curriculum in the United States and other nations? Science and mathematics instruction in the Soviet Union integrate the different disciplines and stress the applicability of the theory into practice. Does curriculum in the United States apply these strategies of curriculum integration and applicability in these content areas? Recent curricular reform in the Soviet Union seems to be in the direction of student inclusion and a move towards topic reduction and, perhaps, course simplification? Are there parallels in current curricular reform in the United States?

In this "glasnostic" time, reports from Soviet classrooms suggest that science and mathematics curriculum in the Soviet Union will continue to be revised with the increasing number of conversations among educators about curricular content and about the goals of their profession.

TABLE 3

TIME SPENT ON BIOLOGY, CHEMISTRY, AND PHYSICS

SUBJECT	NATIONS		
	UNITED STATES	SOVIET UNION	P. R. CHINA
BIOLOGY	180 HOURS 1 YEAR	321 HOURS 6 YEARS	256 HOURS 4 YEARS
CHEMISTRY	180 HOURS 1 YEAR	323 HOURS 4 YEARS	372 HOURS 4 YEARS
PHYSICS	180 HOURS 1 YEAR	492 HOURS 5 YEARS	500 HOURS 5 YEARS

from Aldridge, Bill G. "Essential Changes in Secondary Science: Scope, Sequence, and Coordination." NSTA REPORT, January/ February 1989, pg. 4.

It is hoped that this paper will suggest to the reader that educators in the United States might consider borrowing from our colleagues in the Soviet Union both curricular strategies and the challenging attitudes of educators living through changing times.

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