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ABSTRACT

This paper consists of three articles: (1) "Chinese Mathematics Revision in Accordance with the Teachings of Mao Tse-tung," which shows that Chinese teachers are making concerted efforts to improve both their teaching and curriculum; (2) "Training of Mathematics Teachers in the People's Republic of China," which describes the training provided for a mathematics teacher at the Shanghai Pedagogical University up to 1966; and (3) "The Chinese Mathematical Olympiads: A Case Study," which covers the period 1956-1964 and includes sample paper sets. (MM)

SELECTED ASPECTS OF MATHEMATICS EDUCATION IN THE PEOPLE'S REPUBLIC OF CHINA

by

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CHINESE MATHEMATICS REVISION IN ACCORDANCE

with the

TEACHINGS OF MAO TSE-TUNG

Frank Swetz, Pennsylvania State University, The Capitol Campus*

From 1962 until the present, the Great Cultural Revolution has been transforming the thoughts and lives of the citizens of the Peoples Republic of China. Confucian wisdom has been replaced by the philosophy of Chairman Mao. Reports reaching the West indicate how diligent study of the "Little Red Book" has assisted its readers in "increasing the speed of rotation of my cotton spinning machine from 9,000 r.p.m. to 13,000 r.p.m." or"becoming world table tennis champion" or even in "curing the children at our school of short-sightedness."[1] As with its Confucian predecessor the doctrines of Maoism now form the foundations of the Chinese educational system. The most vociferant attacks of the Cultural Revolution have been directed at education with the result that every subject taught, even mathematics, is considered in the framework of Mao's teachings.

Mao Tse-Tung, in May of 1966, issued a directive specifically aimed at education. Its points included:

1) The period of schooling should be shortened.
2) Education should be "revolutionized" by elimating all bourgeois influence.
3) Greater emphasis should be placed on practical work.[2]

Reinforcement of the policy was expressed in a June editorial in <u>The Peoples Daily</u>[3] entitled "Sweep Away All Monsters".

> --- For the last few months, in response to the militant call of the Central Committee of the Chinese Communist Party and Chairman Mao Tse-Tung, hundreds of millions of workers, peasants and soldiers and vast numbers of revolutionary cadres and intellectuals, all armed with Mao Tse-Tung's thought, have been sweeping away a horde of monsters that have entrenched themselves in ideological and cultural positions.

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> With the tremendous and impetuous force of a raging storm, they have smashed the shackles imposed on their minds by the exploiting classes for so long in the past, routing the bourgeois "specialists", "scholars," "authorities" and "venerable masters" and sweeping every bit of their prestige into the dust.[3]

Obviously, it was felt that "monsters" were present in the teaching of mathematics as this same editorial appeared simultaneously in the Chinese mathematics journals: Acta Mathematica Sinica[4] and The Bulletin of Mathematics.[5] A companion article in the Bulletin entitled "The Great Revolution that Touches the Peoples' Souls" carried the same message - mathematics teaching must conform to the thoughts of Chairman Mao. It was done!

An inspection of the contents of prior Bulletins reveals a list of articles not too disimilar from what can be found in its American counterpart The Mathematics Teacher. However, with the advent of the "Monsters" and "Souls" articles, the direction of the writing changes. Subjects considered now become extremely practical and applied. Such mundane and earthy topics as "How to estimate the number of shoots of rice required for a mou (area measurement) of paddy"[6] and "Methods for calculating the volume of a mound of nightsoil"[7] are presented.

Methods of teaching mathematics are also revised to conform with Chairman Mao's thoughts. In an article entitled "A few methods showing how to learn from Chairman Mao's masterpieces in order to enhance the quality of the teaching of mathematics"[8], a mathematics teaching - research group at a secondary school in Fuchien provence initiate the naive. The following is a condensation of and commentary on this article.

> The revolution in teaching is primarily an educational, ideological revolution reflecting Chairman Mao's masterpieces. In this article we will suggest how this educational ideological revolution should enhance the quality of secondary school mathematics.

Management of the subject matter or organization of content material and classroom teaching, pedagogy, comprise the two main sections of the presentation. Readers are advised by the research group that "Improving

management of the subject matter is not a problem of methodology but it is a problem of conflict between new and old ideologies." Critical self-appraisal of the methods employed in the teaching of geometry in the past reveals a strong dependence on formalism. It is now felt that the emphasis in teaching should consider student preparedness and stress applications of theory to practical situations. Under the influences of the Chairman's thoughts, the group isolates their difficulties in teaching under three headings:

I. Grasping the main conflict.
II. Imparting less, but precise and very clear knowledge.
III. Meeting the students' practical needs.

In discussing their experiences in grasping the main conflict, the authors examine personal attempts over the past two years to improve the performance of algebra classes. Now, however, in the third year of experimentation "advanced" research indicates the students' difficulties lie in:

1. Understanding the meaning of radical expressions and how to identify one.
2. The reduction of radical expressions to simpler forms. (e.g., $2\sqrt{18} = 6\sqrt{2}$)
3. Comparison of the magnitude of radical expressions.
4. Reduction of roots to the simplest form.
5. Calculation of the approximate value of radical expressions.

The agreed upon procedure to aleviate the students' difficulty is to have the teacher present some of the theory to be learned, then have the students extend this knowledge by working problems without assistance. Finally, all the knowledge on the topic will be consolidated through the use of homework assignments. An example of such a sequence is given:

Hence, after we have taught expressions of the form:

$$\sqrt[pn]{A^{pm}} = \sqrt[n]{A^{m}}$$

we should make the students do the following exercises by themselves:

1. Reduce to the simplest root form:

$$\sqrt[10]{(2a)^5} \quad ; \quad \sqrt[10]{9\ a^4b^6}$$

It should be realized that these problems have the same form and can be simplified by the same method. We should also make the students recognize other problems in the same form.

Then we give them this exercise:

2. Simplify $\sqrt{(a)(x)}$; $(\sqrt[3]{x^2})(\sqrt[6]{a})$.

   into the same type of root form. After correcting this problem, we should give them the following problems.

3. $\sqrt{16a^4y^8}$; $\sqrt[6n]{2^{2n}b^{4n}}$; $\sqrt{(x-2)^2}$ where $x<2$.

4. Reduce $\sqrt[3]{-5}$ and $-\sqrt{3}$ into simplest forms.

On their second main point, concerning managing the subject matter, our authors tell us:

> In managing the subject matter we should follow the strategy of quality instead of quantity. Major and minor concepts should be distinguished from each other employing Chairman Mao's theory, "To concentrate on the superiority of the army's power in order to win battles." Teachers should guarantee that students learn the major concepts.

Again geometry is singled out as a discipline in need of revision. Thorough student learning concerning circles and their properties has been hindered by an unnecessary proliferation of concepts. Evaluation as to the concise material needed to remedy this situation is offered in the form of a list of the main points required for achieving an understanding of this circle knowledge. The Chinese teachers also urge that the congruency of triangles be taught from a qualitative rather than a quantitative approach. A pedagogy similar to the one proposed for algebra teaching is advocated allowing two periods for instruction on new material and the following two used by students for problem solving.

In meeting the students' practical needs, the authors express some concern for the psychological process of mathematics learning.

> Chairman Mao says to us, "Precise knowledge is gained by the process of transfer from material to spiritual and from spiritual to material." In other words, from practical experience to knowledge and vice versa. In this case, the cycle is repeated several

> times (concrete → abstract → concrete → abstract). Therefore in the management of the subject matter, we should analyze in depth the applied nature of the material and the students' practical needs. We must establish the students' fundamental knowledge in relation to practical experience in order that they may find utility in their knowledge.

Once again, the reader is instructed to build upon the students' past knowledge, avoid excessive lecturing and have the students learn by practical experience which appears to be having the students solve problems without assistance from the teacher. Students must be made to understand rather than forced into memorization as in the past.

Completing their discussion on "management of subject matter" the Fuchien study group now proceeds to apply the thoughts of Chairman Mao to classroom teaching.

> After having learned the relevant instructions of Chairman Mao, we criticize the remaining remnants of capitalist educational thinking and elements of individualism in teaching. For the sake of the revolution, we are teaching according to the concepts of proletarian education. This is an important institution for the transmission of the Thoughts of Chairman Mao and knowledge to students. We [must] regularly pay attention to the following points:
>
> 1. Practically based knowledge . . .
> 2. Pay attention to "essential teaching and numerous exercises"[9] in classroom teaching. With the phenomenon of "pouring" which existed in the past, the student did not grasp knowledge through understanding. This caused dead study and dead memory. Our serious attention was called to this matter only after having studied the instructions of Chairman Mao. We must do our utmost to lecture "little", lecture "essentials" and lecture well. Pay attention that one lectures what he must lecture, practices what he must practice, and avoids formalism in order that the students will truly obtain knowledge . . .
> 3. Making the students' studies of an active and positive nature causes a lively and quick atmosphere.
>
> Chairman Mao has said, "Materialistic dialectics regards the external element as the condition of change and the internal element as the root of change; the external element passes through the internal element and thus action arises".[10] After studying this teaching of the Chairman, we understand the great significance of "human elements are first" in classroom teaching. By employing varied teaching materials, we hope to promote an interest in learning and change the former classroom situations where the teacher merely lectured and the students passively listened . . .
>
> 4. Note the relationship between theory and practice.

> Chairman Mao has taught us "Through practice one discovers truth, again through practice one confirms and develops truth."

In accordance with this teaching of Mao, the study group has achieved an understanding of the true function of mathematics instruction in the Peoples' Republic and proposes "three great services to the revolution" to be rendered by their colleagues.

> 1. In order to facilitate the class struggle at home and abroad, the content of teachings must be directed towards production.
> 2. Knowledge must be solidified and advanced.
> 3. The ability of the students to solve practical problems must be raised.

Thus the naive reader has received some sophistication into the methods by which the thoughts of Chairman Mao can help him become a better mathematics teacher. Although, perhaps to a Western reader this article may appear to be labored under political rhetoric, its exposition is consistent with Chinese educational theory. Education in China has always been molded by ideological considerations. Centuries ago, Confucian thought, acting as a catalyst in the formation of Chinese educational policies, assisted in the evolution of a system where social harmony was given priority over scientific development. Maoism and the "Great Cultural Revolution" while still very much concerned with Chinese social harmony is attempting to reverse the traditional status of science and mathematics in Chinese school curricula. Existence of articles such as this point to a limited success in achieving this goal. Furthermore several factors concerning the present climate of Chinese mathematics education are worth noting:

1) Chinese teachers are making concerted efforts to improve both their teaching and curriculums. Following a Soviet model, the utilization of research teams or study groups was first instituted in the Peoples Republic in 1952. These groups for the "design and direction" of teaching have done much to increase the Chinese teachers' sense of responsibility and improve school standards according to the latest political directives.[12] There is,

however, no evidence to indicate the existence of national study groups in China such as S.M.S.G. in the United States.[13] Advice to lecture "little", lecture "essentials" and lecture well certainly has a universal pedagogical appeal.

2) Consideration is being given in the Peoples Republic of China to the psychological aspects of mathematics learning. Stress upon working from the concrete to the abstract in a repetitive cycle is not limited to the teachings of Chairman Mao. This Piagetian approach to mathematics teaching is advocated by such Western scholars as Harvard's Jerome Bruner, Zoltan Dienes of Canada's Sherbrooke University and the University of Leeds' Kenneth Lovell.

3) Theory and application form supplementary components in Chinese mathematics instruction. In the West, the Nuffield Project for the Teaching of Mathematics has been employing a similar technique in England with encouraging results.

The "monsters" of formalization and memorization that plague the teachers and students of the Chinese Peoples' Republic also prey upon their capitalist counterparts. Although our journalistic prose may be less bombastic, our pedagogical problems and efforts to overcome them appear strikingly similar.

This article is based upon research performed by the International Mathematics Study Group, under the direction of Professor Bruce Vogeli, Teachers College, Columbia University. Members contributing to Chinese Studies include Laird Marshall, Mario Meza, William Montford and the author. Assistance in the translation of Chinese articles was provided by Bruce Jacobs of Columbia University.

FOOTNOTES

1) G.H.G. Oldham, "Science and Education in China" in Ruth Adams Contemporary China, Random House, New York, 1966. p. 309

2) "A New-Type School Which Integrates Theory with Practice", Current Background (Hong Kong), 12-31-68, p. 11

3) Jen-min Jih-pao, Peking, June 1, 1966

4) Shu Hseuh Hseuh-pao. The Mathematical Society of China.Quarterly, Peking,1966 16:423-425

5) Shu Hseuh T'ung-pao. The Mathematical Society of China.Monthly, Peking July, 1966. 7:1-2

6) Ibid, July 1966, p. 20

7) Ibid, p. 41

8) Ibid, June 1966, pps. 34-36

9) Here the authors refer to the old concept held by some teachers that the student is similar to an empty vessel and knowledge must be "poured" into him.

10) Mao Tse-tung Selected Works 1st ed. (Chinese); p. 72

11) Ibid, p. 65

12) Chung Shih, Higher Education in Communist China. Union Research Institute, Hong Kong, 1953, p. 47

13) John De Francis, "The Mathematics Scene in China", The Mathematics Teacher 1955. p. 251

Training of Mathematics Teachers in the Peoples' Republic of China

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Since the conquest of Mainland China in 1949, the Chinese Communists have undertaken many educational reforms designed to forge an ideologically united and technologically competent state. Early reforms consolidated and strengthened existing facilities. Pre-war American influences in teaching methodology, curriculum design and textbook format were largely replaced by Soviet models. During the period from 1949 until the early Sixties the direction in educational reform was "to learn from the advanced experience of the Soviet Union"; however, the rift in Sino-Soviet relations has resulted even in the rejection of Soviet educational practices. The present principal influence in Chinese education is the Communist Party and its doctrines as set forth in the writings of Chairman Mao Tse-tung.

Understanding of educational reforms in China is contingent upon a knowledge of the educational principles established by Mao Tse-tung. First, education must serve politics since ideological regimentation is fostered through political indoctrination. Second, education must advance proletarianism which in turn will cleanse the nation of "bourgeois contamination" by "intellectualization of the of the proletariat and proletarianization of the intellectuals." Lastly, education must be combined with production with all students and teachers participating in productive labor in factories and in the fields during harvest time.

In its educational reforms, the government has been influenced by the political-economical policy of "walking on two legs" [1] whereby goals are attained by a variety of diverse methods and approaches. A dramatic example of this policy was the blossoming of "backyard steel furnaces" throughout China in the mid-Fifties to supplement the production of large steel mills. In the sphere of education, "walking on two legs" has resulted in the formation of numerous spare-time and part-time schools at various levels to supplement the expanded regular school system. It was reported that in the Spring of 1960, more than 150 million workers and peasants were enrolled in such schools [2]. These "schools" range from literacy classes to technical, vocational, teacher training and even "Red and expert" college and universities where the only criterion for academic excellence is party loyalty and "practical experience". Psychological and propaganda considerations rather than academic standing have resulted in an institution that may consist of a single class or study group being given the dignified title of "school" or

"university". Despite the existence of these bogus "schools", there are many types of bona fide educational institutions in existence in the Peoples' Republic of China. The hierarchy of Chinese educational institutions is summarized in Figure I.

Figure I.

The burden of supplying trained teachers for these schools has fallen upon the traditional training institutions. It should be noted that a high percentage of teachers have had no professional training and many have not even had the minimum academic schooling needed for the teaching of their subjects. Since 1960, the proletarianization of education has reached such extreme levels that in some cases schools have been staffed by peasants. Trained school personnel however are almost always products of normal schools.

Three levels of teacher training institutions exist at present in Mainland China: the junior normal school, the senior normal school, and the higher normal school or university. Courses of study range from 3 years to 5 years in length and short-term courses ranging from 6 months to two years are given to train graduates of the junior middle school as teachers. Crowning the system of normal education are the higher normal schools and universities that besides providing teachers for secondary schools, also provides teachers for the junior and senior normal schools. Early in their reorganization of higher education, the government indicated a preference for teacher training institutions independent from other institutions and universities by ordering the merger of departments or schools of education of various universities into higher normal universities or colleges. From 12 independent higher normal institutions in China in 1950, the number rose to 31 in 1953 and to approximately 60 by 1960. It would be safe to speculate that during the years of internal conflict and purge since 1960, this number has not increased appreciably.

Following the initiation of the "Great Leap Forward" in 1958, some school subjects were abbreviated and others combined to facilitate a shorter period of schooling. Two subjects that did not suffer by this reform were mathematics and the study of the Chinese language. Indeed, every effort was made to keep the level of these disciplines high since literacy is desirable for ideological indoctrination and mathematical competance necessary for technological proficiency. It would be interesting then to examine the training provided for a mathematics teacher at

one leading higher normal school as an example of a priority educational program in Mainland China and perhaps form comparisons with mathematics teacher training in the United States.

The Pedagogical University in Shanghai, founded in 1951, is a higher normal school for the training of secondary school teachers. Courses of study encompassing five years are given in: political education, Chinese language, Russian, English, history, geography, topography, psychology, education, physics, radiophysics, chemistry, biology and mathematics. A staff of 1000, including 200 full professors serve the institution. The school boasts 70 laboratories and a library of one million volumes.

The student body is comprised of 4000 students, 40% of whom are women. These students have completed five years of secondary schooling and have received the party's recommendation for admittance to higher normal school. Prior to 1966, a satisfactory score on an entrance examination was necessary for acceptance at an institution of higher education but this was eliminated as contradictory to the principles of a Communist society [3].

A student at the Shanghai Pedagogical University desiring to major in mathematics must complete the following program

Table I

These courses can be broken down into four broad categories: political training, required and elective mathematics courses, associated technical studies, and educational methodology and research. During the fifth year of training, 200 hours of electives are chosen from areas of mathematics. Concurrently, senior students conduct textbook research that may consist of incorporating the thoughts and teachings of Chairman Mao into existing mathematics texts. In an earlier period, these "research" efforts could have been directed towards translating Russian texts and lesson plans into Chinese.

In comparison with contemporary Soviet teacher training curricula in mathematics, a Russian influence is still evident in the organization of the Shanghai curriculum. The strong concentration on the discipline involved and seeming lack of concern for general education courses such as Educational Psychology, Philosophy of Education or Tests and Measurements reflect Soviet thought in teacher training. Political indoctrination, a required course in Differential Geometry

and required courses in Technical Drawing are also common to both systems [4].

The total number of hours per semester appears small when compared with a normal school timetable for 1958 that averaged 30 hours of course work each week [5]. It should be remembered, however, that such schedules list only time spent in classroom activities. Since 1958, school activities other than formal academic studies have increased appreciably, notably productive labor. Students average 12-13 hour work days -- 4 hours in productive labor, 4 hours in collective discussions with fellow students and teachers concerning lectures and the thoughts of Chairman Mao, 4 hours in academic studies and an hour of physical and compulsory military training.

Productive labor at the Shanghai Pedagogical University is performed at an adjoining factory that manufactures electrical measuring instruments. Although it has a regular full-time staff, this factory is operated by the normal school. Students and instructors fulfill part of their work quota at the factory. During harvest time, assistance is also rendered in the countryside. Professors are required to perform manual labor for at least one month each year. This quota probably has been increased during the period of extreme de-intellectualization since 1966. Due to the applied nature of much of the mathematics studied, a student's academic training is compatible with the work performed in this factory. Thus, in theory, work and study supplement each other.

Pedagogical training for mathematics students consists of one three hour a week course as compared with 4 and 6 hour courses for Physics and Chemistry students respectively. Practice teaching is conducted over a period of six weeks during the fourth year of studies. Students also are expected to gain informal teaching as well as learning experience during their work in the countryside.

Classroom instruction follows the traditional lecture method: no visual or other teaching aids are employed. Class size averages about 40 students per class but in laboratory work, the student-teacher ratio is 8:1. Mathematics coursework appears to be rather classical as indicated by the following list of texts in use in 1966.

Algebra:	Chrystal, G., Textbook of Algebra, 1904. Ferrar, W. L., Higher Algebra For Schools Hall, Henry & Knight, S.R., Elementary Algebra, 1895.
Analysis:	Courant, Richard, Differential and Integral Calculus. 2 vol., 1937 Granville, William, et al. Elements of Calculus, 1946. Hardy, Godfrey, Pure Mathematics, 1959.

Analytic Geometry:	Salmon, George, Conic Sections.
Complex Variable:	Copson, E. T., Introduction to the Theory of Functions of a Complex Variable, 1935.
Differential Equations:	Ince, Edward, Integration of Ordinary Differential Equations.
	Forsyth, Andrew, Theory of Differential Equations, 6 vols., 1890-1906.
Real Variable:	Pierpont, James, Lectures on the Theory of Functions of a Real Variable, 2 vol., 1914.

A newspaper article of 1957 stated, "Books from England and America would merely take up room on the shelves, so they were sold as scrap paper." [6] However, the books listed above, together with the Schaum's Outline Series, were still used in teacher training institutions of Mainland China prior to the Great Cultural Revolution.

A comparison between the mathematical portions of the Chinese teacher-training programs and the recommendations of the Committee on the Undergraduate Program in Mathematics (C.U.P.M.) for the training of secondary teachers of mathematics may prove informative. For comparative purposes Chinese class time has been translated into semester hours (1 hour/week for a semester = 1 semester hour). A semester hour would roughly approximate a credit hour in an American school; therefore an American course of 3 credits would correspond time-wise to a Chinese course of 3 semester hours.

From table II below it appears that Chinese curriculum for mathematics teacher training is equivalent at the elementary level but exceeds the American standards in the advanced courses required. Both curricula specify approximately twenty-four semester hours of work in mathematics at the elementary level with the Chinese requirements in analysis exceeding the American standards and in turn being exceeded in algebra. However, at the advanced level of mathematics the Shanghai school requires eleven hours plus work in electives whereas the C.U.P.M. standards ask for only six hours of electives!

Table II

While this example of Chinese teacher education curricula in mathematics appears to exceed C.U.P.M. standards, it should be emphasized that the Shanghai Pedagogical University is a prestige institution with staff and curriculum that are superior by Chinese standards. Thus, comparisons of American programs with the program of the Shanghai should not be generalized to teacher education in China as a whole. Even if the Shanghai curriculum cannot be generalized it is evident that

teachers enrolled for this and comparable curricula in Mainland China in 1966 should be prepared to discharge their school responsibilities adequately.

Little information is available concerning the effects of the Great Cultural Revolution upon teacher education in China since 1966. The Red Guard terror, the attacks upon teachers and other intellectuals and the prolonged closing of schools and universities no doubt has resulted in interruption of this program. Indeed, there is evidence to indicate that university programs including those of normal universities have been altered significantly with increased emphasis upon the philosophy of Mao Tse-tung and the three P's of Chinese education -- Politics, Proletarianism, and Production. There is also evidence that teachers prepared under formerly strong teacher education curricula have been dismissed from teaching and replaced by peasant and proletarian "barefoot teachers." The effect of the turmoil that has characterized the Chinese political and educational scenes since 1966 is not yet clear. If the Cultural Revolution destroyed or seriously damaged teacher education or other educational programs in mathematics, its impact upon future Chinese achievements in technology and science may be severe.

This report is based upon the writing and research of the International Mathematics Education Study Group, under the direction of Prof. Bruce Vogeli, Teachers College, Columbia University. Members contributing to Chinese studies include Laird Marshall, Mário Meza, William Montford and the author.

References

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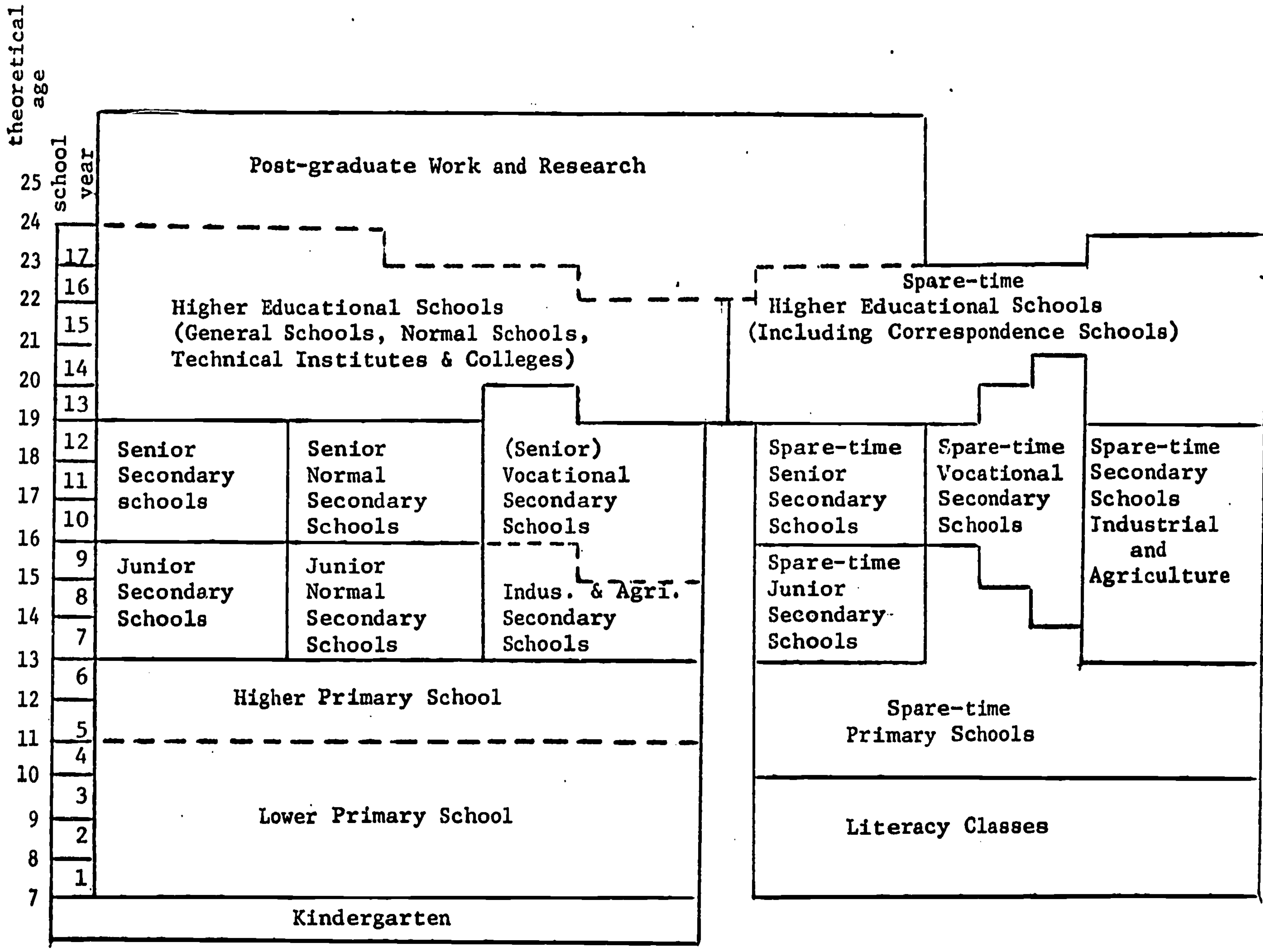
2) Chen, Theodore Hsi-en, Teacher Training in Communist China, Washington, D. C., U. S. Department of Health, Education, and Welfare, 1960, p. 5.
3) Orleans, Lev, Professional Manpower and Education in Communist China, Washington, D. C., N.S.F. 1960, p. 218.
4) Vogeli, Bruce R., "Professional Content in Soviet Teacher-Training Curricula in Mathematics," American Mathematical Monthly, February, 1962, 69:156-162.
5) Chen, Op. cit., p. 18.
6) Chen, Op. cit., p. 37.

SUBJECTS	Weekly Hours by Year & Semester										Total Subject Hours
	I		II		III		IV		V		
	1	2	3	4	5	6	7	8	9	10	
Political Training											
History of Communist Party	2	2									4
Political Economy			2	2							4
Communist Philosophy					2	2					4
Required Mathematics											
Analysis	6	6									12
Higher Algebra		4									4
Analytical Geometry	4										4
Projective Geometry				2							2
Differential Equations						4					4
Func. of Complex Variables								4			4
Functions of Real Variables							3				3
Probability & Statistics						4					4
Differential Geometry								2			2
Physics				5	5	5					15
Theoretical Mechanics							5				5
Technical Drawing	1	1									2
Teaching Methodology								3			3
Textbook Research							X	X	X	X	
Elective Mathematics											
Theory of Functions											Total
Modern Algebra											of
Differential Equations											200
Applied Statistics											Hours
Numerical Computations											Per
Applied Analysis											Year
Total Hours	13	13	2	9	7	15	8+	9+			
(Weeks Per Semester)	18	17	18	17	18	17	18	17			

CURRICULUM FOR MATHEMATICS TEACHERS AT THE SHANGHAI PEDAGOGICAL UNIVERSITY

TABLE I



STRUCTURE OF MAINLAND CHINESE EDUCATIONAL SYSTEM (CIRCA 1960)

FIGURE I

C.U.P.M.		CHINESE	
Analysis	3 courses	Analysis	2 six semester-hour courses
Abstract	2 courses	"Higher" Algebra	1 four semester-hour course
Geometry (be-yong Analytics)	2 courses	Projective Geometry	1 two semester-hour course
		Differential Geometry	1 two semester-hour course
Probability & Statistics	2 courses	Probability & Statistics	1 four semester-hour course
Upper Level Electives	2 courses	Upper Level Required Courses:	
		Differential Equations	1 four semester-hour course
		Functions of Real Variable	1 three semester-hour course
		Functions of Complex Variable	1 four semester-hour course
		Electives:	
		Theory of Functions	
		Modern Algebra	
		Differential Equations	Courses to comprise 200 hours of work in fifth year.
		Applied Statistics	
		Numerical Computation	
		Applied Analysis	

COMPARISION OF MATHEMATICAL REQUIREMENTS FOR MATHEMATICS TEACHER TRAINING IN MAINLAND CHINA AND THE UNITED STATES

TABLE II

The Chinese Mathematical Olympiads: A Case Study

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In 1962, the Monthly contained an article by John De Francis describing the inauguration of a Mathematical Olympiad in the Peoples Republic of China [1]. The article provided a fascinating glimpse of the Chinese State's efforts to nurture mathematical talent among its youth. Since that time, little information has reached the West concerning either Chinese mathematics education or the fate of the Olympiad scheme. Chinese Mathematical Olympiads continued up until 1964 and achieved many of the goals they were designed for: mathematically talented students were located and given special educational attention; the general level of mathematics instruction was elevated and thousands of Chinese students were encouraged to come together in "study groups" for extra curricula mathematics studies. In light of the recent decision to institute a Mathematical Olympiad in the United States, it might prove beneficial to examine the Chinese experience, its execution and its consequences.

The Conception and Execution of the Chinese Mathematical Olympiads

During a visit to the Soviet Union in April of 1946, Hua Lo-keng, Director of the Institute of Mathematics of the Chinese Academy of Science, was impressed by the enthusiastic response given by secondary school students to a lecture on complex numbers by P. S. Aleksandrov of Moscow University. These students were members of study groups preparing themselves for participation in the Soviet Mathematical Olympiads. Returning to Russia in 1953, with a delegation from Academica Sinica, Hua and his colleagues were advised by Soviet educators to instigate mathematical competitions in China as a method of promoting scientific advancement. The consensus was that through

such activities Chinese youth would be stimulated toward mathematics studies thus forcing an improvement in the quality of school mathematics and science instruction. Firmly convinced of the potential national benefits of mathematical competitions, Hua suggested their adoption in the Peoples Republic of China as an extra-curricular activity but also cautioned against a resulting disruption in the regular school system [2]. The examinations were not to interfere with the school's normal functions. He was supported in this campaign by Tuan Hsueh-fu, professor at Peking University, who urged Chinese educators to "learn from Russia" concerning mathematical competitions [3].

Early in 1956, activities began in earnest to implement Hua and Tuan's recommendations. Mathematics competition committees were established in Peking, Shanghai, Tientsin and Wuhan. They were responsible for local organization of contests and for setting examination questions. Shanghai's committee was composed of seventeen members selected from the Mathematical Society, the Shanghai Municipality Education Office and the local chapter of the Chinese National Association of Natural and Special Sciences. In the choosing of examination questions, the committees limited their selection to topics from arithmetic, algebra, geometry and trigonometry that while rigorous did not exceed content required by middle school mathematics outlines. Similar to the Soviet scheme, associated student lectures on various aspects of mathematics were to be given. The initial lecture in this series was presented on March 11 by Professor Su Pu-Chin. His topic was "Non-Euclidean Geometries".

In May the first examination was undertaken. Students in the last two years of middle school were given a screening examination by their teachers. Those who did well and were politically acceptable were recommended to represent their schools in city-wide competition. The official examination was composed

of two rounds with the final winners emerging from the second round. Each round contained five or six problems in a given time allotment of one hundred fifty minutes. Students who passed the first round were awarded a certificate of merit and allowed to compete in the second round. Success at the last level warranted a medal and an award of books. The competitors with the three best scores were permitted entrance to the universities of their choice to study either mathematics, physics, astronomy or any other associated scientific discipline without being subjected to further examinations. Naturally, the accomplishment of doing well in such an examination brought great recognition to the young scholar and for a short period he became a local hero much like the successful civil service candidates of old. On May 4th, Wuhan conducted its examinations and had twenty-one students pass. Sixty-two Peking middle schools sponsored six hundred twenty-two students in the final round of its competition of May 13th. Thirty-three passed. Tientsin's examination on May 27th had four hundred ninety-nine participants in the final round with twenty-five passes. Shanghai's Olmypiad was given in early June and saw seven hundred thirty-two contestants in the second round. (No information is available as to the number of final winners) [4]. Although the examination efforts in these four cities were considered experimental, they were acclaimed outstanding successes. Shanghai's experiences of 1956 and the following year, 1957, were well documented and published to serve as a guide for other cities to follow [5].

One hundred thirty thousand copies of <u>Compilation of Problems from the 1956-57 Mathematical Competitions for Middle-School Students in Shanghai Municipality</u> were published and distributed in 1958. In this booklet the ultimate objectives of the competitions were specified: to locate mathematically talented students so they could be singled out for special educational attention and to encourage self-study and a competitive spirit among students. Both

objectives were intended to raise the quality of mathematical training for Chinese students so that the Peoples Republic of China could compete, scientifically, with the more developed nations of the world.

As a result of the competitions, mathematics study groups were formed in many schools. Students engaged in extra-curricular activities designed to improve their performance on up-coming examinations. Study groups existed on several levels: within schools; among several schools and at the city-wide level. By 1962, the Peking Mathematics Study Group boasted a membership of seven hundred. Members came together once a month to hear a lecture by a prominent mathematician and to engage in discussions concerning his presentation [6]. Often the lecturer would pose specific problems to be solved by his audience. In 1960, the Office of Mathematics, Physics and Logic of the Institute of Mathematics of the Chinese Academy of Science organized a series of twenty lectures to be presented in future months and designed for student study groups. These lectures centered on four themes:

1) An introduction to the study of mathematical foundations.
2) Outline of the history of mathematics.
3) The nature, methods and significance of mathematics.
4) The techniques and characteristics of modern mathematics [7].

Eventually, many of the lectures were published in pamphlet form for further and more widespread study by student groups [8].

These lectures and publications were part of a broad government sponsored campaign to promote the study of science. At the forefront of this campaign was Hua Lo-keng. Mathematician of world renown, concerned teacher and confirmed advocate of the Communist Party's policies, Hua was to be emulated as the socialist model of a scholar-scientist. The story of his proletarian

background and "Horatio Alger" raise to success despite adversity was communicated to the youth of China with the hope that it would encourage them to be persistent in achieving their educational ideals. The People's Publishers in Shanghai printed his biography, The Mathematician Hua Lo-keng and Hua, himself, wrote To a Young Mathematician in which he included autobiographical sketches and encouragement to students [9]. Hua was indeed a self-made man worthy of admiration. Although lacking higher academic degrees, he has written several classical works of mathematics; is a versatile researcher and world recognized authority in number theory, harmonic analysis of functions of several complex variables and group theory [10].

In subsequent years since 1956, the level of achievement on the competitions has increased. This record is due largely to the influence of student mathematics study groups. The 1962 competitions in Peking attracted one thousand four hundred and sixty-five students from one hundred schools, six hundred ninety three seniors and seven hundred seventy-two juniors representing five percent of their respective grades city-wide. On the first round nearly half of the seniors scored about 60% correct. The second round was quite difficult but one student did solve all the required problems [11]. Of the eighty-two eventual winners, half were members of the Peking Mathematics Study Group [12]. From data available on the 1963 competitions, it appears that all student participants took both examinations rather than being screened out by the first round.

Table 1

Peking Municipality Mathematical Competitions

April 12, 1963 (8:00-9:00 A. M. and 9:30-11:30 A. M.) [13]

Junior Level Examination: First Round

1. 10 people are grouped into two clubs, each club consisting of 5 members. In each club a president and a vice-president are chosen. How many ways can this be done?

2. Given: $\sin\alpha + \sin\beta = p$, $\cos\alpha + \cos\beta = q$, find the values of $\sin(\alpha+\beta)$ and $\cos(\alpha+\beta)$.

3. Solve the simultaneous equations:

$$\sqrt{x-1} + \sqrt{y-3} = \sqrt{x+y}$$

$$\lg(x-10) + \lg(y-6) = 1$$

4. The lengths of the sides of a right triangle form three consecutive terms of an arithmetic progression. Prove that the lengths are in the ratio 3:4:5.

5. Let D be a point on the arc $\widehat{BC}$ of the circumscribed circle about the equilateral triangle ABC. Let E be the intersection of the lines AB and CD, F the intersection of the lines AC and BD. Prove $\overline{BC}$ is the geometric mean of $\overline{BE}$ and $\overline{CF}$. $[\overline{BC}^2 = \overline{BE} \cdot \overline{CF}]$

Junior Level Examination: Second Round

1. Let $x^3 + bx^2 + cx + d$ be a polynomial with integral coefficients, and let $bd + cd$ be odd. Prove the polynomial is not the product of two polynomials, each with integral coefficients.

2. Suppose 5 points are given in the plane, no 3 on a line, no 4 on a circle. Prove there exists a circle through 3 of the points such that of the remaining 2 points, one is in the interior and the other is in the exterior of the circle.

3. Let P be a point in the interior of a regular hexagon whose sides have length 1. The line segments from P to two vertices have length 13/12 and 5/12 respectively. Determine the lengths of the segments from P to the 4 remaining vertices.

4. Let a be a positive integer, and let $r = \sqrt{a+1} + \sqrt{a}$.
Prove that for any positive integer n there exists a positive integer a_n satisfying: $r^{2n} + r^{-2n} = 4a_n + 2$

$$r^n = \sqrt{a_n+1} + \sqrt{a_n}$$

Senior Level Examination: First Round

1. If $2 \lg(x-2y) = \lg x + \lg y$, find $x:y$.

2. Let r and R be the radii respectively of the inscribed and the circumscribed circles to a regular n-gon whose sides have length a. Prove: $r + R = \frac{a}{2} \cot \frac{\pi}{2n}$

3. Find the coefficient of x^2 in

$$(1+x)^3 + (1+x)^4 + (1+x)^5 + \cdots + (1+x)^{n+2} .$$

4. Given a convex n-gon, call the line segment joining two non-adjacent vertices a diagonal. Assume no 3 diagonals intersect in a common point. Find the number of intersections of diagonals (in the interior of the n-gon).

5. A trapezoid is given with parallel edges of lengths a and $2a$. A side of the trapezoid has length b and forms an acute angle α with the edge of length $2a$. Find the volume of the solid of revolution determined by rotating the trapezoid about the side of length b.

1. Let $P(x) = P(x) = A_k X^k + A_{k-1} X^{k-1} + \cdots + A_1 X + A_0$ be a polynomial with integral coefficients. Suppose x_1, x_2, x_3, x_4 are dintinct integers such that $P(x_i) = 2$ for $i = 1,2,3,4$. Prove that $P(x)$ is not 1,3,5,7, or 9 for any integer x.

2. Let 9 points be given in the interior of the unit square. Prove there exists a triangle of area $\leq \frac{1}{8}$ whose vertices are 3 of the 9 points.

3. $2n + 3$ points are given in the plane, no 3 on a line, no 4 on a circle. Is it possible to find a circle through 3 of the points such that of the remaining $2n$ points, half are in the interior and half are in the exterior of the circle? Prove your answer.

4. 2^n counters are divided into several piles. The following defines a move: choose two piles A and B, say with p and q counters respectively, $p \geq q$; move q counters from A and put them in pile B. Prove there exists a finite number of moves such that all counters end up in one pile.

The Conclusion and Consequences of the Examination Scheme

It was originally hoped that the mathematical competition schemes would eventually be adopted by all large cities in China. Although the movement did spread from the four cities that inaugurated the tests, it did not achieve the momentum expected. Perhaps in many locals, the mathematical talent and organizational ability for such an endeavor were lacking. The era of "anti-championism" in the sixties and the Great Cultural Revolution terminated the examinations. Under pressure from the red guards Hua had to publicly confess his sin of promoting "advanced experience from abroad" in the Peoples Republic [15]. The competitions were denounced as contributing to elitest education practices by encouraging personal achievement. In the years between 1956 and 1964, the existence of the competitions did much to mould the mathematical thinking patterns of Chinese students. The questions stressed creative thinking over rigid solution methods dictated by rote-learning experiences. Thousands of students benefited from this exposure. Now in the wake of the Great Cultural Revolution, it remains to be seen if the educators in the Peoples Republic of China will consider this fact important enough to resurrect the mathematical competitions.

Footnotes

1. John De Francis, "Mathematical Competitions in China", the Monthly, 1962

2. Hua Lo-keng, "We Will Have National Mathematics Competitions Soon", Shuxue Tongbao, Chinese Mathematical Association, Peking, January 1956. pp. 1-3.

3. Tuan Hsueh-fu, "Learn from Russia to have Mathematical Competitions", Shuxue Tongbao, January 1956, pp 3-5.

5. Shang-hai shih, 1956-57 nien chung hsueh-sheng shu-hsueh ching-sai his-t'i pien-hui, (Compilation of Problems from 1956-57 Mathematics Competitions for Middle-School Students in Shanghai Municipality), New Knowledge Press, Shanghai 1958.

6. Han Erh-Tsai, "They Like Mathematics" China Reconstructs, Peking, December 1962, 11:34-35.

7. "Office of Mathematics Physics and Logic of the Institute of Mathematics of the Chinese Academy of Science Sponsors Lectures on Mathematics Foundations", Shuxue Tongbao, February 1960, p. 42.

8. Shuxue Tongbao, September 1962, Back cover. This Series of Mathematics for Youth included the following works:

Hua Lo-keng, Discussions Starting From π of Tsu Ch'ung
Discussions Starting from the Triangle of Yang Hui

Wu Wen-chun, Applications of Mechanics in Geometry

Shih Chi-huai, Averages

Tuan Hsueh-fu, Symmetry
Induction and Deduction

Min Szu-hao, Lattice Points and Area

Chiang K'en-ch'eng, One Stroke Diagrams and the Mailman's Route

Tseng K'en-cheng, One Hundred Mathematical Problems

Ch'ang Keng'che and Wu Jun-sheng, Complex Numbers and Geometry

9. Shu Hsueh Chia Hua Lo-keng, The Mathematician Hua Lo-keng, People's Publishers, Shanghai, 1956; Hua Lo-keng, To a Young Mathematician China Youth Press, Shanghai, 1956.

10. Some of his publications include: Additive Prime Number Theory, Chinese Academy of Sciences, Peking, 1953; Harmonic Analysis of Functions of Several Complex Variables in Classical Domains, Izdat. Inostra. Lit., Moscow, 1959; Classical Groups; Shanghai Science an Technology Press, 1963 (with Wang Yuan).

11. "Conclusions of the 1962 Mathematics Contest Among Middle School Students in Peking Municipality", Shuxue Tongbao, April 1963, pp 50-51.

12. Han, Op. cit., p 35.

13. "1963 Peking Municipality Mathematical Competitions" Shuxue Tongbao, May 1963, back cover; Other published examination questions can be found in: "1957 Peking Municipality Mathematical Competitions", Shuxue Tongbao, May 1957, pp 38-44; "1957 Tiensin, Wuhan and Nanking Mathematical Competitions", Shuxue Tongbao, August 1957, pp 45-46; and Compilation of Problems from 1956-57 Mathematical Competitions for Middle-School Students in Shanghai Municipality, Op. cit.

14. Chao Ts'u-keng, "On the Problems Adopted for the 1963 Mathematics Contest for Peking Middle School Students:, Shuxue Tongbao, July, 1963, pp 8-14.

15. Hua Lo-keng, "Chairman Mao Points Out the Road of Advance for Me", China Reconstructs, November, 1969, pp 30-31 and 41.