

Construction of Further Education Curricula System for Math Teachers of Senior High Schools¹

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Further education for teachers is required for reforms of elementary education curricula and their career development. Principles of relevance, selectivity and hierarchy should be followed in the construction of further education curricula system for math teachers of senior high school. The following curricula should be included in the system: A. moral elevation and idea renewal curricula; B. theoretic curricula on math education; C. curricula on math education design; D. curricula on math education research; E. curricula on modern educational technology; F. curricula on knowledge renewal and extension.

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0. INTRODUCTION

To keep up with its fast economic development, elementary education in China has witnessed considerable reforms at the beginning of the twenty-first century. In July 2001, the Ministry of Education issued (MEPRC 2001c) *The Standards of Math Curricula for Full-time Compulsive Education* (trial version), and in April 2003 (NDMEPRC 2003b) *The Standards of Math Curricula for General Senior High Schools* (trial). The success of this reform depends largely on whether there are a large number of highly qualified teachers. Therefore, in September 2004 the Ministry of Education launched the “Training Plan for all Elementary and High School Teachers 2003–2007.” The author, appointed by the Educational Department of Guangdong Province, is in charge of the project, with this article among the production.

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1. THE NECESSITY OF CONSTRUCTION OF FURTHER EDUCATION CURRICULA SYSTEM FOR SENIOR HIGH SCHOOL MATH TEACHERS

1. 1. Further education is the most important part of education for teachers.

The process of educations for teachers includes three stages—higher education, professional training and on-the-job training. Previous education just focused on the first and the second one, oblivious of the third. The development of modern society has made lifelong learning a basic way of living, in which teacher will fail to meet the needs of society without lifelong education. Therefore, the education for teachers highlights, differently from before, the professional training and on-the-job training, with the latter proving to be the most efficient way to upgrade teachers' quality and thus improve the quality of education.

1. 2. Further education for teachers is required for the specialization of teachers.

(NDMEPRC 2003a) International education heads towards specialization of teachers. At the very outset of specialization of teachers in China, further education for teachers is the only way to make competent and qualified teachers. Teachers mature to real professionals through on-the-job training to upgrade their professional expertise.

1. 3. Further education for teachers is required for extensive promotion of quality-oriented education and reforms of elementary education curricula.

Extensive promotion of quality-oriented education and reforms of elementary education curricula require more high quality teachers than before. At the moment, the overall quality of teachers in China, especially those in the countryside, is far from satisfactory. Therefore, (MEPRC 2001b) construction of lifelong learning system for teachers, organization of another round of training, as well as the build-up of a team of high quality and specialized teachers essentially underlie the success of extensive promotion of quality-oriented education and reforms of elementary education curricula.

1. 4. Further education for teachers is required for their career development.

The “project of further education for elementary and high school teachers” has had positive outcome in vocational training and training for core teachers. Teachers, however, have stepped up the demands for their own career development under the new circumstances of extensive promotion of reforms in elementary education, as the developments of scholastic profession continues. Professor Wang has shown in his study (Wang 2004) that: out of the total 6 subjects in serial 3 Optional Curricula, more than

half of the math teachers under study were not familiar with 5 subjects, which were information security and code, spherical geometry, symmetry and group, Euler Formula and classification of closed surfaces, trisection of angles and number system expansion. Out of the 10 subjects in serial 4 Optional Curricula, 70% of teachers didn't know much about 4 subjects, which were optimization methods and experimentation design elements, scheduling methods and graph theory elements, risks and decision, switching circuit and Boolean algebra. Teachers harbor great desires for studying new subjects, which will surely be satisfied by another round of further education for teachers, to the benefit of the general development of scholastic profession.

2. GUIDING IDEOLOGY AND GOALS FOR CONSTRUCTION OF FURTHER EDUCATION CURRICULA SYSTEM FOR SENIOR HIGH SCHOOL MATH TEACHERS

According to the Instructions from the Ministry of Education on Accelerated Nationwide Promotion of Teachers' Education Network Association Plan, Organization and Implementation of Another Round of Training for Elementary and High School Teachers, an open and efficient further education curricula system for scholastic profession in math should be constructed to highlight professional ethics, new concepts, new curricula and new technology, with the goal of building up a team of high-caliber professionals for math teaching. The following goals should be realized by organization and launch of another round of extensive training for all senior high school math teachers:

- (1) To Strengthen teachers' political ideology and professional ethics; to foster new ideas of fair education, democratic education, initiative education and personalized education; to construct ideologies in compliance with quality-oriented education on education, human resources and quality.
- (2) To improve math teachers' ability to conduct teaching and undertake research;
- (3) To expand and optimize math teachers' professional knowledge structure, and advance their career development.

3. BASIC PRINCIPLES IN CONSTRUCTION OF FURTHER EDUCATION CURRICULA SYSTEM FOR SENIOR HIGH SCHOOL MATH TEACHERS

- (1) Principle of relevance: The system should be greatly relevant to reforms of elementary education curricula and go strictly with the career development of

math teachers.

- (2) Principle of selectivity: According to the variety of teachers' needs, the system should offer a diverse "curricula menu," combining compulsory courses with optional courses.
- (3) Principle of hierarchy: The system should be set according to general development of teachers, that is, from fresh hands to general teachers to core teachers and to experts' teachers.

4. THE FRAMEWORK OF FURTHER EDUCATION CURRICULA SYSTEM FOR SENIOR HIGH SCHOOL MATH TEACHERS

According to the principles above, the following curricula should be included:

- A. Moral elevation and idea renewal curricula to foster in trainees modern education ideas and upgrade professional ethics of trainees.
- B. Theoretic curricula on math education to give trainees a deeper understanding of the process of math teaching and thus offer theoretic back-up and technical guidance.
- C. Curricula on math education design to sharpen trainees' teaching skills and enable them to tailor proper ways of teaching according to students' characteristics and environments.
- D. Curricula on math education research to better trainees' ability to undertake math education research implant in them a new teaching attitude, which is as objective and conscientious as required in education research, thus shifting the previous passive teaching to an active one.
- E. Curricula on modern educational technology to equip trainees with modern education techniques for both teaching and courseware development.
- F. Curricula on knowledge renewal and extension to expand and optimize trainees' professional knowledge structure and also enhance their career development.

5. FURTHER EDUCATION CURRICULA SYSTEM FOR HIGH SCHOOL MATH TEACHERS

5. 1. Course setting

Table 5. 1. Course setting (NDMEPRC 1998)

Category	Number	Courses	Fresh hands	General teachers	Core teachers	experts teachers	Credit hours	Credit
A	1	Professional Ethics for Teachers	C	C	C	C	8	2
	2	Laws and Regulations for Education	C	C	C	C	8	2
	3	Ideas of Quality-oriented Education	C	C	C	C	8	2
	4	Math Education Philosophy	C	C	C	C	16	4
B	5	Interpretation of Standards of Mathematics Curricula for General Senior high Schools (trial)	C	C	C	C	24	6
	6	Psychology for math learning and teaching	C	C	C	C	24	6
	7	Modern Math Education Theory	C	C	C	C	12	3
	8	Math Education Evaluation			C	C	12	3
	9	Visions on International Math Education Development					12	3
C	10	Math Teaching Techniques	C				24	6
	11	Math Teaching Design	C				16	4
	12	Analysis of Teaching Materials for Compulsory Math Courses		C			16	4
	13	Analysis of Teaching Materials for Optional Math Courses		C			24	4
	14	Case Study of Teaching Research			C	C	16	4
D	15	Education Statistics and Measurements					16	4
	16	Research Methods for Math Education			C	C	24	6
	17	Advances in Reforms of Math Education Home and Abroad				C	8	2
E	18	Modern Education Technique Foundation	C	C	C	C	32	8
	19	Math Courseware Manufacture	C	C	C	C	28	7
F	20	An outline of Modern Math				C	16	4
	21	History, Culture and Thinking Methods of Math					16	4
	22	Math Exploration					16	4
	23	Math Modeling					16	4
	24	Extension of Probability & Statistics Knowledge					16	4
	25	Primary Number Theory and Cryptology					24	4
	26	Combinatorics					16	4
	27	Graph Theory					16	4
	28	Operational Research					16	4
	29	Statistics Applications					16	4
	30	Spherical Geometry					16	4
31	Symmetry and Group					16	4	

32	Euler Formula and Closed Surface					16	4
33	Trisection of Angle and Number Field Expansion					16	4
34	Optimizing Method and Test Design Elements					16	4
35	Risks and Decision					16	4
36	Switching Circuit and Boolean Algebra					16	4
37	Specialty English for Math Education				C	16	4
38	The Profile of Modern Scientific Achievements					16	4
39	Humane Science Profile					16	4

* Note. C stands for Compulsory

5. 2. Course indicating

A. Moral elevation and idea renewal curricula

1. Professional Ethics for Teachers

Goals and requirements: to strengthen professional ethics and get familiar with professional modes in teachers

Main contents: basic theories of morals and ethics, psychological quality, professional moral modes for teachers, noble deeds of model teachers

Suggestions on teaching: 8 credit hours, 2 credits; in-class instruction combined with listening to reports of noble deeds; compulsory for all teachers; evaluation by checking.

2. Laws and Regulations of Education

Goals and requirements: to get familiar with current education regulations of China; foster ideas of conducting education by law; strengthen the legal consciousness of obligations and rights.

Main contents: basic issues and important spirits of education regulations and major education policies, like the *Education Law of the People's Republic of China*, the *Compulsory Education Law of the People's Republic of China*, the *Teachers Law of the People's Republic of China*, the *Law of the People's Republic of China on the Protection of Minors*, the *Regulations of the People's Republic of China on Teachers Qualification*, and the *Programs for Education Reforms and Development of China*.

Suggestions on teaching: 8 credit hours, 2 credits; in-class instruction combined with case study; compulsory for all teachers; evaluation by checking.

3. Ideas of Quality-oriented Education (MEPRC 2001a)

Goals and requirements: to renew conventional education ideas and construct ideas of

quality-oriented education.

Main contents: ideas of quality-oriented education; rational thinking on quality education concepts; quality-oriented education cases.

Suggestions on teaching: 8 credit hours, 2 credits; in-class instructions; compulsory for all teachers; evaluation by checking.

4. Math Education Philosophy (Zheng 2004)

Goals and requirements: to know major schools in math philosophy, understand all kinds of math education ideas and comprehend the essence of math education.

Main contents: major schools in math philosophy, several kinds of math education ideas and philosophical foundation for math education reforms

Suggestions on teaching: 16 credit hours, 4 credits; in-class instruction; optional for all teachers; evaluation by checking.

B. Curricula on math education theories

5. Interpretation of Standards of Math Curricula for General High Schools (trial) (Yan, Zhang & Wang 2004)

Goals and requirements: to understand basic ideas and goals of new math curricula for senior high school, and get familiar with its framework, content and requirements for course implementation.

Main contents: ideas, goals, content, framework and implementation of the courses.

Suggestions on teaching: 24 credit hours, 6 credits; combination of in-class instruction and seminars; compulsory for all teachers; evaluation by checking.

6. Psychology for Math Learning and Teaching (He 2004)

Goals and requirements: to understand and master modern learning theory, comprehend thoroughly the essence of math teaching, construct the ideas of students and teaching in new courses, and master the psychological laws of learning and teaching of mathematical concepts, principles and problem solving, thus helping upgrade the trainees' teaching skills.

Main contents: learning theory of stimulus-response, cognitive learning theory, essence of math teaching, analysis of psychology in teaching and learning process of mathematical concepts and principles, mathematical problem solving.

Suggestions on teaching: 24 credit hours, 6 credits; combination of in-class instruction and seminars; compulsory for all; evaluation by examination.

7. Modern Math Teaching Theories (Hans 1994; Tang & Zhu 2001; Zhang, Li & Li 2003)

Goals and requirements: to master basic ideas of modern math teaching theories; upgrade trainees' level in both theories and design of math teaching.

Main contents: modern math teaching theories, constructivism in teaching, and modern math teaching models.

Suggestions on teaching: 12 credit hours, 3 credits; in-class instruction; compulsory for all teachers; evaluation by checking.

8. Evaluation of Math Teaching (Ma, Zhang, etc. 2003)

Goals and Requirements: to renew ideas of evaluation and master basic approaches for evaluation of new math courses.

Main contents: concepts and methods for appraisal of new course, appraisal of math teaching in classes, appraisal of math learning of students, case study on appraisal of math education.

Suggestions on teaching: 12 credit hours, 3 credits; in-class instruction; optional for new hands and general teachers while compulsory for core teachers and education experts; evaluation by checking.

9. Visions on International Math Education Development (Sun 2003)

Goals and requirements: to know the concepts, goals and content of math courses in different countries and keep track on the development of international math courses.

Main contents: math courses in America, the UK, Holland, Russia, Japan, Germany and Singapore, respectively.

Suggestions on teaching: 12 credit hours, 3 credits; in-class instruction; optional; evaluation by checking.

C. *Curricula on math education design*

10. Math Teaching Techniques (Zhang & Song 2004)

Goals and requirements: to master math teaching Techniques.

Main contents: math teaching techniques and case study of in-class math teaching

Suggestions on teaching: 24 credit hours, 6 credits; combination of learning, observing, practicing and seminars; compulsory for new hands and optional for the rest; evaluation by checking

11. Math Teaching Designs (Ma 2003)

Goals and requirements: to master the basic requirements and useful approaches for math teaching design, and to upgrade the ability to design math teaching.

Main contents: introduction of math teaching design, analysis for preparation of math teaching design, establishment of goals in math teaching, planning of math teaching,

planning of teaching mathematical concepts, planning of teaching mathematical propositions, planning of teaching how to solve mathematical problems, and planning of giving review classes.

Suggestions on teaching: 24 credit hours, 6 credits; combination of in-class instruction and seminars; compulsory for new hands while optional for the rest; evaluation by checking.

12. Analysis of Teaching Materials for Compulsory Math Courses

Goals and requirements: to understand the ideas underlying the teaching materials, master the frameworks, goals and requirements of the teaching materials.

Main contents: the underlying ideas, frameworks, goals and requirements of the teaching materials.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; compulsory for general teachers while optional for the rest; evaluation by checking.

13. Analysis of Teaching Materials for Optional Math Courses

Goals and requirements: to understand the ideas underlying the teaching materials, master the frameworks, goals and requirements of the teaching materials.

Main contents: the underlying ideas, frameworks, goals and requirements of the teaching materials.

Suggestions on teaching: 24 credit hours, 6 credits; combination of in-class instruction and seminars; compulsory for general teachers while optional for the rest; evaluation by checking.

14. Case Study Teaching Research (Kathrine 2001; Li & Li 2001)

Goals and requirements: master the basic requirements and implementation procedures of organizing case study and learn step by step how to design mathematical cases for study.

Main contents: basic concepts and requirements of case method; implementation of case method; selected collections of cases.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction, seminars and practice; optional for new hands and general teachers while compulsory for core teachers and education experts; evaluation by checking.

D. Curricula on math education research

15. Education Statistics and Measurements

Goals and requirements: to master basic ways of collecting, arranging and analyzing

relevant information and upgrade the ability to conduct research on math education.

Main contents: primarily collecting and analysis of statistic data, probability and normal distribution, statistic inference, characteristic measurements, significance test of difference, analysis of variance and F Test, T Distribution and test, χ^2 Test, measure techniques of teaching.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional for all; evaluation by checking.

16. Research Methods for Math Education (William 1995; Zhang, etc. 1998)

Goals and requirements: to master basic approaches of math education research and improve the ability to conduct math education research.

Main contents: determination of the research subject, consultation with relevant literature, experimental research, investigation and surveys, qualitative study, composition and publication of research reports.

Suggestions on teaching: 24 credit hours, 6 credits; combination of in-class instruction and seminars; optional for new hands and general teachers while compulsory for core teachers and education experts; evaluation by checking.

17. Advances in Reforms of Math Education Home and Abroad (Xu 2001)

Goals and requirements: to know the trends of math education reforms and try to conduct some reform where it is possible.

Main contents: the past and the present of math education development home and abroad, hot issues of math education reform, trends in math education development.

Suggestions on teaching: 8 credit hours, 2 credits; in-class instruction; compulsory for education experts while optional for the others; evaluation by checking.

E. Curricula on Modern Educational Technology

18. Modern Education Technique Foundation

Goals and requirements: to foster ideas of modernization of education and master basic up-to-date education techniques.

Main contents: modernization of education and teaching, fundamental principles and instruction for operation of common media, computer-aided teaching and online teaching.

Suggestions on teaching: 28 credit hours, 7 credits; combination of demonstration, operation and in-class instructions; compulsory for all; evaluation by examination.

19. Math Courseware Manufacture

Goals and requirements: to master techniques and methods of math courseware development, and acquire the ability to develop math courseware.

Main contents: how to use PowerPoint, Geometry Drawing Board, Mathematics and the multi-media software, Author ware to develop courseware.

Suggestions on teaching: 32 credit hours, 8 credits; combination of in-class instruction and practical courseware development; compulsory for all; evaluation by checking.

F. Curricula on knowledge renewal and expansion

20. An outline of Modern Math (Zhao 2002)

Goals and requirements: to know the profile, achievements and thinking ways of modern math.

Main contents: profile of modern math, modern math subjects and some developments of modern math.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; compulsory for experts while optional for the rest; evaluation by checking.

21. History, Culture and Thinking Methods of Math (Deng, Sun & Zhang 1990; Li 2002)

Goals and requirements: to know the history of math development, understand thinking methodologies in it and upgrade math attainments.

Main contents: early arithmetic and geometry, the ancient Greek math, the ancient Chinese math treasure, the birthday of calculus, set theory from Cantor, and the development of the thoughts of randomness.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional for all; evaluation by checking.

22. Math Exploration

Goals and requirements: to understand the connotation, importance, and characteristics of math exploration, to master the basic approaches of math exploration and improve the capability for mathematical discovery.

Main contents: connotation, importance, characteristics, basic methods, teaching requirements and cases of math exploration.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional for all; evaluation by checking.

23. Math Modeling

Goals and requirements: to master basic ways of math modeling and enhance the ability to apply mathematics to practical problem solving.

Main contents: math modeling elements, application of Mat lab, interpolation and fitting, numerical integration and differential, the shortest path problem.

Suggestions on teaching: 16 credit hours, 4 credits; in-class instruction; optional for all; evaluation by tests.

24. Extension of Probability Statistics Knowledge

Goals and requirements: to expand knowledge in probability statistics and upgrade the ability to use the new teaching material.

Main contents: selections of applied probability, selections of analytical probability, parametric estimate, hypothesis testing, applied stochastic process.

Suggestions on teaching: 16 credit hours, 4 credits; in-class instruction; appraisal by tests.

25. Primary Number Theories and Cryptology

Goals and requirements: to master primary numerical theory, deepen the understanding of numerical system and upgrade the ability to apply numerical theory to information science.

Main contents: the application of exact division theory, congruence theory, quadratic residue theory and number theory in information security.

Suggestions on teaching: 24 credit hours, 6 credits; in-class instruction; optional for all; evaluation by tests.

26. Combinatorics

Goals and requirements: to master the basics of combinatorics and improve the ability of solving relevant problems.

Main contents: drawer principle and its application, inclusion-exclusion principle and its application, difference theory and its application; recurrence relation.

Suggestions on teaching: 16 credit hours, 4 credits; in-class instruction; optional; evaluation by tests.

27. Graph Theory

Goals and requirements: to master the rudiments of graph theory and be able to conduct simple application.

Main contents: basic concepts of graph, trees, and a few kinds of parent map; important parameters of graph and simple application of graph theory.

Suggestions on teaching: 16 credit hours, 4 credits; in-class instruction; optional; evaluation by tests.

28. Operational Research

Goals and requirements: to understand basic concepts and principles of operational theory and upgrade the ability to apply math to solve problems.

Main contents: linear programming, dynamic programming, network program evaluation and review technique, and technique of comprehensively planning.

Suggestions on teaching: 16 credit hours, 4 credits; in-class instruction; optional; evaluation by tests.

29. Statistics Applications

Goals and requirements: to know modern applications of statistics and master some useful statistical methods; to be able to use relevant statistical software for problem solving.

Main contents: statistical theory and computational model, study and discussion of typical cases and computational practice.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

30. Spherical Geometry

Goals and requirements: to be clear of the differences between plane geometry and spherical geometry, and the nature of spherical geometry; to expand geometric horizons.

Main contents: spherical geometry in practical problems, the nature of spherical geometry, elements of Non-Euclidean geometry, and the unified classical geometry

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

31. Symmetry and Group

Goals and requirements: to understand concepts of transformation group and master the nature and application of symmetrical transformations.

Main contents: symmetrical figures and symmetrical transformation, the nature of symmetrical transformation, the practical application of symmetric groups and group theory.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

32. Euler Formula and Closed Spherical Surface

Goals and requirements: to understand the invariant properties of geometrical figures in different transformations and be able to classify curves and surface with the aide of topological invariant.

Main contents: transformations and classification of plane figures, invariant properties of geometrical figures, Euler formula and Euler characteristic, topological transformation, classification of curves and closed spherical surface, and simple applications of topology.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

33. Trisection of Angles and Number Field Expansion

Goals and requirements: to understand the ways of thinking in application of number field extension theory to the solution of three great construction problems, and realize the role axiomatic theory plays in providing solutions.

Main contents: three great construction problems in ancient Greek, concepts and examples of number field and extension field, algebraic method and three great problems in geometric construction.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional for all; evaluation by checking.

34. Optimum Seeking Method and Test Design Elements

Goals and requirements: to understand the ideas of optimum seeking method and test design, master basic techniques of optimum seeking method and test design, and be able to put them to practical application.

Main contents: one-factor optimum seeking method, multiple factors optimum seeking method, batch test design, and orthogonal test design

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

35. Risks and Decision

Goals and requirements: to understand the basic ways of risk decision and be able to work out solutions to relevant problems.

Main contents: concepts and measurement of risks, general principle of decision-making, basic approaches of risk decision, elements of game theory

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

36. Switching Circuit and Boolean Algebra

Goals and requirements: to comprehend concepts of Boolean algebra, circuit function and circuit polynomial; to understand the relation between switching circuit and propositional calculus and upgrade the ability to use Boolean algebra for problem solving.

Main contents: switching circuit, Boolean algebra, switching circuit and propositional calculus, cases of application of Boolean algebra.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

37. Specialty English for Math Education

Goals and requirements: to acquire the elements of reading and expression in specialty English for math education.

Main contents: reading materials on math for high schools; reading materials on math education.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

38. The Profile of Modern Scientific Achievements

Goals and requirements: to expand scientific horizons, upgrade scientific attainments and improve the knowledge structure.

Main contents: fundamental characteristics of the development of modern technology; the fresh accomplishments in the fields of information, new material, new energy source, space and oceans, bio-engineering, etc.; consequent influences of the new technologies on social production and life.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; compulsory for education experts while optional for the rest; evaluation by checking

39. Humane Science Profile

Goals and requirements: to know the profile and development of modern human science and upgrade attainments in human science.

Main contents: the profile of development of modern humane science; the impact of humane science like philosophy, economics, sociology, laws, literature, history and so on, on the development of society.

Suggestions on teaching: 16 credit hours, 4 credits; combination of in-class instruction and seminars; optional; evaluation by checking.

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