# Construction of General Education of Technical University: Experience and Implications of General Education in Massachusetts Institute of Technology*

Ruishu Wang
School of Humanities and Law
Foreign Studies College
Northeastern University
Shenyang, China

Wanbing Shi**
Research Centre of Special Education
Nanjing Normal University of Special Education
Nanjing, China
** Corresponding Author

*Abstract*—**General education courses are the main method of implementing general education in universities. As a world-class technical university, Massachusetts Institute of Technology has rich experience in general education construction, and it has important reference and enlightenment significance for the reform of general education in many technical universities in China.**

*Keywords—massachusetts institute of technology; general education construction; technical universities; experience and implications*

## I. INTRODUCTION

The implementation of general education reform in technical universities is different from that of comprehensive universities. Also it is different from liberal arts-based universities. The general education reform in technical universities has its own advantages and characteristics, but it also has its own limitations. How to develop the advantages, characteristics and the general education model of technical universities is a key issue that must be solved in the reform of general education in technical universities. The reform is mainly focused on liberal arts and it is trying to promote general education among the students in technical universities. So far, it has achieved some initial results, but there are still some difficulties in the process of the reform. In this kind of situation, it might be feasible to properly draw on the general education construction experience and implications of world-class technical universities.

General education originates from the liberal education in ancient West Times. And in the development of American higher education, general education is a kind of higher education thought and practice education that combines the liberal education in the Western Europe with the local practice education of the United States. Over these years, general education reform has become one of the most important reforms in American universities. And it is mainly reflected in offering students a larger elective space in the flexibility of the system, the tendency of diversified curriculum and curriculum content, and the fiercely competitive of the general education between different universities. The general education of American universities aims to emphasize college students to receive professional education and meanwhile promote them to learn the basic knowledge of other disciplines to break through the limitations of specialized education in terms of knowledge, ability and interest in order to support students to be better development in the future. The Massachusetts Institute of Technology (MIT) is known as "the best technical university in the whole world". Although it is a technical university, it is not lack of humanity education. Instead, it does a really good job in general education construction. In this paper, researcher researched on MIT's general education and provided a comprehensive and detailed study of MIT's latest general education report from the MIT official website. The component information of the construction of MIT's latest general education was analyzed and observed. The successful construction of MIT's general education benefits from the strength of teachers and the scientific research, but teaching and students' development are the key points that be emphasized on. Although the humanities curriculum is the core content of general education in MIT, general education does not mean or be not limited to humanities components. Therefore, MIT's general education cannot be equated with MIT's liberal arts education. In fact, the vision and ambition of MIT's general education is much higher than that of MIT liberal arts education. It is a more ambitious and complete educational program, which has accumulated more than 100 years of exploration by MIT's principals and educators. It plays a vital role in the reform of general education construction in technical universities.

## II. BASIC INFORMATION OF GENERAL EDUCATION CONSTRUCTION IN MIT

The general education components in MIT are called General Institute Requirements (GIRs) that are compulsory for all students. The GIRs include the following six

components: six core science components, two science and technology limited components, one component with twelve units or two required component with six units, respectively, eight humanities, arts and social sciences (HASS) components, four communication required components and four physical education components[1]. The general education in MIT is not only about the content of humanities, arts and social sciences. The basic theory of natural sciences is also the core content of general education in MIT. In addition to the basic theory components in the natural sciences, the HASS general education curriculum occupies almost half of the MIT's general compulsory components, with a total number of eight. If students take one component in one semester, then eight components could last for four academic years which is equivalent to the entire undergraduate study of the students. MIT's HASS education includes distribution component (HASS-D), Concentration Component (HASS-C), and Elective Component (HASS-E). Each of them provides multiple components choices for students to choose. In terms of the depth of the component, the three types of components are in different levels.

The distribution component is the easiest part in the general education in MIT, and it emphasizes the interest and foundation of the curriculum itself. The focus of this part is on cultivating students' interest in a specific knowledge field of HASS. In order to arouse students' interest in learning knowledge, it is necessary to provide students with a variety of opportunities and possibilities for learning and experience. Thus, MIT offers students more than 600 hours of distribution curriculum options. In terms of categories, MIT's distribution curriculum is divided into three categories: Humanities (HASS-H), Arts (HASS-A), and Social Science (HASS-S). Among them, the humanities curriculum emphasizes proximity and the social science curriculum emphasizes the methodological norms of modern social sciences with a stronger positive spirit. In principle, all students must choose one of the three categories in the distribution curriculum. In the eight components of HASS, the distribution curriculum occupies three of them.

Apart from distribution component, concentration component is also the top priority for MIT's HASS education. One of the core points highlighted in the Lewis report is to strengthen the depth and level of MIT's HASS research. For this reason, MIT has established a liberal arts college. Therefore, graduates from MIT not only have a basic HASS vision, interest, and foundation, but also have a deep understanding of a certain field of HASS. And centration courses are designed to achieve this aim. There are a total number of twenty-nine areas in a centration education program. Each student is required to select three to four courses in one of these areas for continuous and follow-up study and research. The 29 categories of centration courses are as follows: "studies of Africans and African Diasporas", "American studies", "Ancient and Medieval Studies", "Anthropology", "Archaeology and Archaeological Sciences", "Art, Culture and Technology", "Studies of Asian and Asian Diaspora", "Comparative Media Studies", "Development Economics", "Ethics", "Foreign Languages and Literature", "Latin American and Latino Studies",

"Linguistics", "Literature", "Middle Eastern Studies", "Music", "Philosophy", "Political Science", "Psychology", "Religious Studies", "Russian and Eurasian Studies", "Science", "Technology and Society", "Dramatic Arts", "Urban Studies", "Women and Gender Studies", "Writing", etc.

Among these 29 centration courses, some courses are designed for centration component. Some other courses can be not only used as centration component, but also be converted into professional minor courses after the study reaches a certain stage. Apart from distribution and centration component, MIT has also designed a range of elective component to enhance the flexibility of the HASS curriculum education system.

The successful reform of general education in MIT must be supported by a good curriculum management system: the faculty. The school's faculty is fully responsible for the school's major education policy decisions, and general education is only a part of the decision-making content. Under the faculty of MIT, there are some different committees which are set up to be responsible for consulting and researching on different aspects of school governance. The two main committees which are responsible for general education construction are the Committee of Curricular and the Committee of Undergraduate Program. The main task of the Committee of Curricular is to supervise the setting, modification and abolition of the curriculum. The main function of the Committee of Undergraduate Program is to supervise the overall project. In 2009, in order to strengthen the general education of the liberal arts, MIT also established the Subcommittee on the HASS Requirement under the Committee of Undergraduate Program to support and encourage the innovation and development of the HASS curriculum [2].

## III. CHARACTERISTICS OF GENERAL EDUCATION CONSTRUCTION IN MIT

### A. Science Course: Emphasizing Basic Scientific Concepts and Methods

The aim of science course is to promote students' understanding and mastering the basic concepts and methods of physics and biological sciences, which play an important role in the future of professional learning and life. Students need major in six core subjects, including "Mathematics", "Physics", "Biology", "Chemistry', "Experimentation" and "Restricted Electives in Technology". Specific content includes some basic scientific method elements, such as experimental foundations and techniques, mathematical analysis, and conceptual models for experimental facts [3]. In addition to providing students with an introduction to science, these contents also provide students with an explanation of natural phenomena and applied technology to provide opportunities and challenges to reflect on their own knowledge and explore alternative concepts and mathematical formulas. Students could take relevant physical, math or chemical foundation subjects which emphasize some basic scientific concepts and methods of the science

curriculum, laying the foundation for the implementation of science and technology limited elective courses.

### B. Communication Course: Promoting the Coordinated Development of Writing and Oral Competence

The communication course is designed to enhance students' writing and oral communication skills to ensure that all undergraduates could receive substantial guidance and practical opportunities in general discourse writing, speech, and common discourse in the professional field. The communication course specifically includes four communication-intensive (CI) which runs through the undergraduate study life. Among the four subjects, two of them are from the subjects of the humanities (arts, social sciences, CI-H), and the other two are from the students' majors (CI subjects in their major program, CI-M). The CI-H course includes history, politics, economics, education, diplomacy, language, culture and many other fields of humanities and social sciences, such as "The Human Past: Introduction to Archaeology", "Visual Perception and Art", "Introduction to Education: Understanding and Evaluating Education" and so on [4]. CI-M courses are closely linked to various disciplines such as "Civil and Environmental Engineering", "Mechanical Engineering", "Electrical Engineering and Computer Science", "Biological Engineering, Economics", "Management", "Political Science", etc. [5]. After the freshman enroll in school, before the communication course, all MIT students must participate in the Freshman Essay Evaluation (FEE) to measure which subjects are suitable for which group of students to study. For example, if students get five points in advanced pre-requisite language and essay exams or in advanced pre-requisite literature and essay exams, or seven points in English A or B Advanced International Baccalaureate exams, then these students will have the opportunity to participate in any CI-H subjects[6], including a writing-focused CI-H subject (CI-HW), such as "Expository Writing for Bilingual Students", "Writing About Literature", "Writing and Rhetoric: Rhetoric and Contemporary Issues", "Science Writing and New Media: Explorations in Communicating about Science and Technology" and so on [7]. After that, students must complete one of the CI-H subjects or CI-HW subjects at the end of the first year. The communication course spans the humanities, arts and social science courses and professional courses, which could promote the collaborative development of students' writing and oral ability, and strengthen the organic combination of general education and professional education, and highlight the influence value of the concept of eclecticism.

### C. Humanities, Arts and Social Sciences Courses: Enhancing the Understanding of Humanities, Arts and Social Activities

The Humanities, Arts and Social Sciences course aims to develop students' broad understanding of human society, historical traditions and cultural systems, deepen students' understanding of knowledge in multicultural and interdisciplinary fields, and encourage students to develop their own emotions and skills no matter whether the student

is an individual, a member of the professional field, or a member of society. All these courses could help students pursue an effective and happy life in the future. Through the study of humanities, arts and social science courses, students could develop communicative skills, accumulate human culture and historical knowledge, experience the ideological system of human activities, and understand the social, political and economic and artistic self-expression of different groups. The MIT Humanities, Arts and Social Sciences courses are usually divided into HASS-Distribution, HASS-Concentration, HASS-Elective, and HASS-Exploration. HASS-Distribution, HASS-Concentration and HASS-Elective have already been introduced in the last section, and here the author only gives a brief introduction of HASS-Exploration. Exploration courses are subject-based courses based on different disciplines and interdisciplinary perspectives. For example in the fall of 2015-2016, the exploration courses included "How to Stage a Revolution", "Writing with Shakespeare", "Globalization: The Good, the Bad and the In-Between", "The Supernatural in Music, Literature and Culture" and so on [8].

### D. Restricted Elective in Science and Technology Courses: Focusing on the Inheritance of Science Education

Compared with the Humanities, Arts and Social Sciences curriculum, the Restricted Elective in Science and Technology Courses (REST) helps students expand and deepen basic science education and lay the foundation for understanding scientific research. Through these courses, students will have the opportunity to continue to expand existing research areas or explore other areas where they may have potential interests. There are a variety of Restricted Elective in Science and Technology Courses for students to choose. Some subjects address basic concepts and principles in a particular field, while others illustrate attitudes, problems, and methods in a particular area of expertise. In general, these subjects cannot be too specialized and too deep, mainly to guide students to obtain a particular skill. Typically, REST courses require students to start their studies in the first year, but students generally begin their studies in the second year. Specific courses include "Introduction to Neuroscience", "Fundamentals of Materials Science and Engineering", "Introduction to Statistical Methods in Economics, Environmental Earth Science", and so on [9]. These courses are not only the deepening and expansion of student science courses, but also the basis for future scientific research in a certain field. In summary, REST focuses on the connection of science education, which is a bridge between the science course of general education and the professional science research course of professional education.

### IV. EVALUATION OF MIT GENERAL EDUCATION COURSE

Since 1997, the curriculum evaluation in MIT has been focusing on general education courses. In 2008, the online course evaluation system was launched. The network evaluation saved manpower and time resources and improved the efficiency of students, teachers and managers participating in the evaluation work [10].

### A. Time of Evaluation

The evaluation period set by the evaluation system is two weeks before the last class of the semester, and the evaluation results are announced within 10 working days after the system is closed. Students can participate in the evaluation at any time during the end of the semester evaluation period. During the evaluation period, students can continually modify the evaluation results. If the course ends in the middle of the semester or the second half of the semester, it is evaluated through a dedicated login window. On the first day of the evaluation period, the computer system automatically sends an activation email with the link URL to all students enrolled in the course, and the reminder email would be sent to those students who have not started the evaluation every few days.

### B. Method of Evaluation

As long as students have already enrolled in the course, they could click on the website according to the evaluation time and follow the prompts to complete the evaluation process. All questions are optional and students could skip any question. Student evaluation could save part of the content in stages, or it can be done in one time. Once students start answering the question, even just answering only one question, the system will no longer send reminder information to students.

### C. Results of Evaluation

The results of the evaluation report are published after all the results have been processed, so as to avoid the impact of the evaluation results on the student's grades. Teachers could view quantitative evaluation results as well as open-ended questions or suggestions, while students could only view the former one. In the evaluation results, the constructive feedback provided by students is particularly important. Teachers could adjust and improve the concept, content and method of future course teaching, and select the most useful suggestions among the evaluation results. The department could use feedback for promotion and evaluation and curriculum adjustments, etc.

### D. Steps of Evaluation

The course evaluation process at MIT is a little bit complicated. The content of the course evaluation is divided into policy and operation procedures and technical support. Each item is divided into three steps: collecting teaching data, conducting a questionnaire, and publishing the results of the survey. The requirements for each step vary depending on the actual situation of the department.

### E. Scale of Evaluation

The evaluation scale of the MIT general education course corresponds to the curriculum plan and it is divided into two categories: science and engineering, humanities, arts and social sciences. Taking the humanities, arts and social sciences course as an example, the first-level indicators of the curriculum evaluation scale consist of six parts. The first part is about basic information, including course number,

teacher name, teacher title, etc. The second part is about the quality of teaching and it includes whether the teacher could stimulate students' interest in the course, well-organize lectures, encourage role-playing learning, organize discussions or not, etc. The third part is about electronic resources, including teaching software, network resources, video media, etc. The fourth part is about the coursework, including the relevance of reading and learning, whether the teachers' evaluation of writing could help students to understand the content of the course or not, etc. The fifth part is about the study evaluation, including students' understanding of the concepts in the course, whether the learning objectives are clear or not and the overall satisfaction with the course learning. The last part is open-ended questions section, including evaluation of teaching, evaluation of course content, constructive feedback on teachers' improved teaching, etc.

## V. EXPERIENCE AND IMPLICATIONS OF THE GENERAL EDUCATION COURSE IN MIT

### A. The Clear Goal of General Education Course

Under the efforts of past principals and teachers, MIT has established a clear goal of general education, which is to train students with a broad scientific foundation and cultural background to enhance students' values, historical perspectives, cognitive styles and innovative ability enables students to create knowledge, self-renewal, adapt to the changing needs of the society and the changes in the social environment.

### B. Pursuing the Balance Between Science and Humanities, Arts and Social Science

General education is a kind of university education concept. It is a non-professional. The purpose of general education is to cultivate socially responsible citizens and to cultivate "complete people" education. Therefore, the content of the general education curriculum should not be limited to the humanities and social sciences, but should achieve a balance between science and humanities. Although MIT is known for its science and engineering education, it places special emphasis on the status of humanities, arts, and social sciences in general education. From the perspective of curriculum and unit allocation, the humanities and science courses each account for half of the whole general education program. In addition, MIT offers science, technology, and engineering courses as part of a general education curriculum that teaches students the general principles, methods, and knowledge of science. These characteristics are worthy of reflection and reference from the research universities of science and engineering in China.

### C. Taking into Account the Personality and Commonality of Student Development

Although general education is a general education for all students, it does not mean that all students need to choose the same course. It should take into account the needs of students' interest and personality development in various

ways. The design and implementation of the MIT general education curriculum is a good balanced model between student personality and common learning. From a common point of view, all students are required to complete the study requirements of the general education course, and each of the science and humanities courses must be completed with 8 units. Each class has compulsory courses and credit requirements. There are a number of elective courses and small courses, and the courses are also diverse. Each class also has two levels of basic and advanced, which meet the needs of students' individual development. This is very instructive for the problems of unclear objectives, vagueness and lack of flexibility in the general education courses of Chinese universities.

### D. Developing a Scientific Curriculum Evaluation System

Curriculum evaluation is an important method to measure the effectiveness of the implementation of the general curriculum. Also it is an important way to promote the continuous improvement of the quality of the curriculum. MIT has established a professional curriculum evaluation system, using network evaluation methods to improve evaluation efficiency; standardizing the evaluation steps of data collection, questionnaire implementation and results publication; establishing two types of evaluation issues: policy and operation, and technical support. The scientific evaluation indicators include 6 first-level indicators. The correct use of evaluation results makes it helpful, supervising and guiding significance for students' learning and teachers' teaching development. In addition, the evaluation time and evaluation methods of students are also very scientific and reasonable. These evaluation features strongly guarantee the quality of the general education curriculum in MIT. Some Chinese universities have not yet established such an evaluation system for general education courses. These questions are worthy of reflection from Chinese universities.

## VI. CONCLUSION

The clear general education development goal, pursuing the balance between science and humanities, arts and social science, taking into account the personality and commonality of student development and developing a scientific curriculum evaluation system are all indispensable factors in the success of MIT's general education. These valuable experiences have important inspiration and reference for the construction of China's current two-tier universities, especially the general education reform of science and technical universities, and the development requirements of the construction of two-tier universities. The success of MIT's general education is the outcome of long-term continual exploration and adjustment, adapting to the needs of social development in different periods. Therefore, the development of general education in China's colleges and universities needs to be based on their respective developmental advantages, clarify the goal of general education, adapt to the needs of social development, and formulate different training programs for general education in order to become a world-class university.

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