Philosophy and Significance of JICA's Assistance in Mathematics and Science Education

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Philosophy and Significance of JICA's Assistance in Mathematics and Science Education

Contents

Abbreviations ····· iii
Introduction ····· 1

1. Development and Assistance in Mathematics and Science Education

1-1. Trends in Approaches to Development Assistance, Science & Technology, and Mathematics & Science Education ····· 3
(1) Mathematics and Science Education for the Elite (1960s - 1970s) ····· 3
(a) Approaches to Development and Education ····· 3
(b) Status of Science and Assistance in M&S Education ····· 5
(2) M&S Education as Basic Education: From the Second Half of the 1980s until the First Half of the 2000s ····· 5
(a) Approaches to Development and Education ····· 5
(b) Status of Science and Assistance in M&S Education ····· 6
(3) Education for Innovation: 2000s (up to the present) ····· 6
(a) Approaches to Development and Education ····· 6
(b) Status of Science and Assistance in M&S Education ····· 6

1-2. Developments in and Characteristics of JICA's Assistance in M&S Education ····· 6

2. Goals of JICA's M&S Education Assistanc

2-1. Philosophy and Significance of JICA's M&S Education Assistance ····· 8
(1) Significance of M&S Education for Character Building ····· 8
(2) Significance of M&S Education for Development ····· 8
(a) Achieving a Secure Life: Seeking a Better Life and Security at the Individual Level ··· 8
(b) Creating a Growing Society: Towards the Development and Stability of Countries ··· 10

2-2. JICA's Policies and Approaches to M&S Education Assistance: Future Directions ····· 11
(1) JICA's Policy and Approach to M&S Education Assistance ····· 12
(a) JICA's policy on M&S Education Assistance ····· 12
i) Aim of JICA's M&S Education assistance: practicing student-centered lesson ····· 12
ii) Focus of JICA's M&S Education assistance: transforming teachers' practices ····· 13
(b) JICA's Approach to M&S Education assistance ····· 14
i) Introducing and entrenching lesson planning: lesson structuring ····· 14
ii) Introducing and entrenching lesson study: learning teachers ····· 15
(2) Future Directions for JICA's M&S Education Assistance ····· 16
(a) Expanding the Scope of M&S Education Assistance ····· 17
(b) Disseminating the Knowledge Acquired through Years of M&S Education Assistance 21

References ····· 22

Appendices

Appendix 1: Current Status and Challenges for Mathematics and Science Education (M&S Education) in Developing Countries ····· 25
Appendix 2: Facts and Figures about JICA's M&S Education Assistance ····· 28

List of Figure, Table, Boxes and Charts

Figure

Figure 1: Number of JICA Technical Cooperation Projects in Basic and M&S Education ····· 1

Table

Table 1: Trends in Development and Assistance in M&S Education ····· 4

Boxes

Box 1: Abilities and Attitudes That Can Be Acquired by Science Education ····· 9
Box 2: Student-Centered Lesson ····· 13
Box 3: Lesson Planning ····· 15
Box 4: Lesson Study ····· 16
Box 5: Japan's Comparative Advantages in M&S Education ····· 17
Box 6: From Project to Program ····· 19
Box 7: Technical Cooperation as Capacity Development Assistance ····· 20

Charts

Chart 1: JICA's Technical Cooperation Projects in Basic Education and M&S Education (Number of Technical Cooperation Projects Launched) ····· 28
Chart 2: List of Technical Cooperation Projects in M&S Education (with Project Periods) ····· 29
Chart 3: Change in the Number of M&S Education Teachers Dispatched under the JOCV Program (FY1995 - FY2005) ····· 30
Chart 4: Number of M&S Education Teachers Dispatched under the JOCV Program by Country ··· 31
Chart 5: Participants in Thematic Training Courses for M&S Education in Japan (between FY2000 and FY2005) ····· 33
Chart 6: Participants in Third-Country Training in M&S Education (between FY2003 and FY2006) ··· 34
Chart 7: Mathematics and Science Teachers (M&S Teachers) Accepted under the Youth Invitation Program (between FY2000 and FY2005) ····· 35
Chart 8: Examples of Coordination between Grant Aid and Technical Cooperation in M&S Education ····· 38

Abbreviations

ADEA	Association for the Development of Education in Africa
BHNs	Basic Human Needs
CD	Capacity Development
EFA	Education for All
FTI	Fast Track Initiative
ICT	Information and Communication Technology
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
JOCV	Japan Overseas Cooperation Volunteers
M&S Education	Mathematics and Science Education
MDGs	Millenium Development Goals
MEXT (Japan)	Ministry of Education, Culture, Sports, Science and Technologies
S&T	Science and Technology
TIMSS	Trends in International Mathematics and Science Study
TVET	Technical and Vocational Education and Training
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNESCO	United Nations Educational, Scientific, and Cultural Organization
PRESET	Pre-service Teacher Education and Training
INSET	In-service Teacher Education and Training
PDM	Project Design Matrix

Philosophy and Significance of JICA's Assistance in Mathematics and Science[1] Education

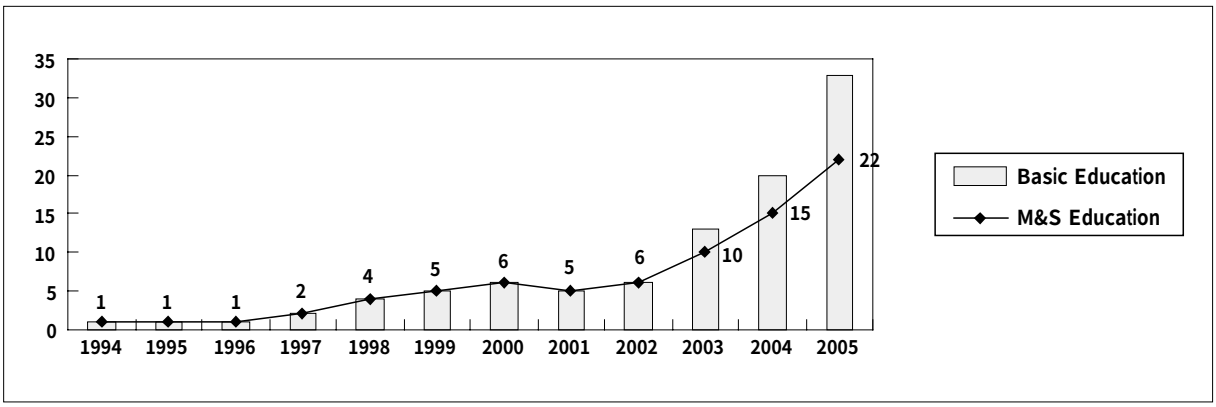
Introduction

Significance of education can be explained from the two different perspectives. First, it is a basic human right. Second, it supports the development of countries by providing individuals with the knowledge and skills required for survival and by helping them to fully develop their abilities and utilize their potential as a member of society.

As the pivotal organization for implementing the technical cooperation of the Japanese government, the Japan International Cooperation Agency (JICA) has focused on education among other strategic sectors including rural development, health, and infrastructure development. Specifically, JICA has placed particular emphasis on basic education which constitutes the basis for acquiring knowledge and skills required for living.

JICA's development assistance in basic education dates back to 1966, when the agency assigned volunteers in mathematics and science education (M&S Education) to developing countries as part of the Japan Overseas Cooperation Volunteers (JOCV) Program. The JOCV Program remained at the center stage in JICA's basic education assistance in the 1970s and 1980s. The situation began to change at the turn of the 1990s. In the 1990s grant aid projects, many of which aimed to construct primary schools, began to increase in number. From 1994 JICA started to implement technical cooperation projects to improve M&S Education. Of the technical cooperation projects in basic education in 2005, two out of three (22 out of 33) were associated with M&S Education (see Figure 1).

Figure 1 Number of JICA Technical Cooperation Projects in Basic and M&S Education



[1] In this paper, "mathematics" refers to "arithmetic/mathematics" and "science" refers to the subject areas such as general science, physics, chemistry and biology.

JICA's basic education assistance has thus expanded rapidly for the past decade, and developing countries' requests for JICA's M&S Education assistance have remained unabated. These circumstances demand to firmly establish JICA's cooperation principles and determine future directions in M&S Education. Responding to this issue, this paper reviews how JICA has heretofore managed technical cooperation projects in this field to indentify the significance of cooperation in M&S Education in developing countries.

1. Development and Assistance in Mathematics and Science Education

1-1. Trends in Approaches to Development Assistance, Science & Technology, and Mathematics & Science Education

Development approaches have changed according to the social context and dominant ideas and theories of the times, and so have approaches to education development. In this context, the following subsections look chronologically at how M&S Education and development assistance in this field have been perceived, and what roles they have played in the international community (see Table 1). This review takes note of two aspects of M&S Education: character building and human resource development. The second aspect is of particular importance from the viewpoint of national development because M&S Education plays a significant role in building a basis for the technological and economic development of countries.

The period from the 1960s to the present can be divided into three phases as shown below.

(1) Mathematics and Science Education for the Elite (1960s - 1970s)

(a) Approaches to Development and Education

The mainstream development theory from the 1950s to the 1960s maintained that the major obstacle to the development of developing countries was the economic structures which were over-dependent on primary commodities. Industrialization was considered to be the key to development at that time. With government-led industrialization regarded as the linchpin of development strategies, large-scale investments were made in the infrastructure sectors including transport, power generation, irrigation, and communications.

The mainstream approaches to education in the context of development experienced a major change at the turn of the 1960s. Education was now recognized as investment in human capital rather than “consumption” in the economic sense. This change prompted increases in public spending and development aid; mainly from multilateral donors, in education. Education at the time was largely seen as a means of human resource development and national education plans were more like manpower plans. Developing countries placed a premium on secondary education and M&S Education. Reflecting this situation, the development assistance in education was directed largely to secondary and higher education, and vocational/technical education.

Amid the high economic development at the global level in the 1960s, however, economic gaps widened between the developed and developing countries, and among developing countries themselves. The idea that economic development alone was not sufficient to achieve poverty reduction gained currency. In the 1970s, consequently developing countries began to adopt policies designed to ensure that increases in the capital and income resulted from economic development of whole country would be redistributed among the people living in poverty and would increase job opportunities. The mainstream development economists at the time were beginning to think that developing countries lacked not only

Table 1 Trends in Development and M&S Education Assistance

	Trends in development	International view on science and its influence on science education in developing countries	Role of and view on education	Mainstream approaches to development assistance in education	Cooperation of donors on M&S Education	Cooperation of JICA on M&S Education
1960s	・Emphasis on economic development, infrastructure investment ・Human capital theory	・Emphasis on science education for elite minority / emphasis on experimental processes ・Lack of teachers with adequate subject knowledge	・From "education as consumption" to "education as investment" based on the human capital theory	・Focus on secondary and higher education and vocational training	・Focus on equipment provision for M&S Education (e.g. 70% of UNICEF's aid for primary and secondary education)	・Started to assign M&S teachers under the JOCV Program (1966)
1970s	・Meeting basic human needs (BHNs)	・Emphasis on basic education ・Training of mid-level technicians ・Emphasis on experiments	・Education as a basic human need	・Non-formal education for the poor	・Focus on TVET & practical subjects at the secondary level ・Low-cost equipment for science experiment develops	・Technical training ・Aid in vocational and technical education
1980s	・Neoclassical economics ・Fiscal austerity ・Structural adjustment	・From "science for the elite" to "science for all"	・Emphasis on the rate of return ・Efficiency approach	・Budget decrease ・Shift in focus from higher to primary education	・Few projects implemented ・Many studies on science education conducted	
1990s	・Human development ・Neo-institutional economics ・Governance ・Poverty reduction, Pro-poor growth	・M&S as a basis for industrialization and higher education ・Scientific literacy as basic education under "EFA [2]" slogan / Science as basic education	・Education for All ・Emphasis on basic education	・Emphasis on basic education (improvement in access)	・Donors increasingly incorporated science education as part of basic education [3]	・Primary schools firstly constructed in 1990 through grand aid ・2 reports on future directions of JICA firstly published [4] ・Technical cooperation projects on M&S Education increased (1994-)
2000s	・Diversified development issues ・MDGs ・Globalization	・Science at the primary and secondary levels ・Mathematics as an advantage in employment	・Dakar Framework for Action [5] ・Human rights-based approach	・More emphasis on basic education (improvement in quality)		・Regional cooperation program for M&S Education (2003-) ・"Thematic Guidelines on Basic Education" published (May 2005)
	・Knowledge-based society	・Education for innovation	・Education for innovation	・A wider scope to include post primary education	・Secondary and technical education ・Teacher training	

Source: Compiled from Sawamura (1999) and King (1991).

[2] EFA movement is a global commitment to provide quality basic education for all children, youth and adults. The movement was launched at the World Conference on Education for All in 1990, when representatives of the international community agreed to universalize primary education and massively reduce illiteracy by the end of the decade.

[3] This is because it became difficult for donors to justify supporting higher and vocational training because of the international emphasis on basic education.

[4] The title of the reports are as follows: "Assessment of the International Trends in Development Assistance in Education and Future Directions for JICA's Assistance"(March 1991); and "Study on Development Assistance for Development and Education" (January 1994).

[5] The Dakar Framework for Action is a re-affirmation of the vision set out in the World Declaration on Education for All. It expresses the international community's collective commitment to pursue a broad-based strategy for ensuring that the basic learning needs of every child, youth and adult are met within a generation and sustained thereafter. The Dakar Framework sets six major EFA goals and proposes twelve major strategies.

physical infrastructure capital, but also human capital, making it necessary to invest in education, health and so on. The World Bank and other donors made a major shift in strategic focus from developing infrastructure to meeting basic human needs (BHNs), including access to education, health services, safe water, nutrition, and shelter to eradicate poverty. In consideration of this change, aid in education focused on practicing literacy education, promoting basic education, and enhancing technical training.

(b) Status of Science and Assistance in M&S Education

In the 1960s, M&S Education in developing countries was limited to the elite, who are considered valuable human resources and serve as an engine for modernization. The curricula focused on scientific experiments that required experimental instruments and equipment that were found in developed countries. In the 1970s many donors lost their interest in M&S Education under the policy of promoting non-formal education and meeting minimum learning needs.

(2) M&S Education as Basic Education: From the Second Half of the 1980s until the First Half of the 2000s

(a) Approaches to Development and Education

In the 1980s debt accumulation stemming from the second oil crisis in 1978 was a major and urgent issue for developing countries. In order to address this issue, many developing countries implemented structural adjustment policies under the auspices of the International Monetary Fund (IMF) and the World Bank. The main strategy of the structural adjustments was highlighted by fiscal austerity, a market-based economy, and privatization. Many developing countries adopted this strategy and reduced government spending on education, which led to deterioration of the quality of education.

The reduced spending on education called for more efficient use of resources and thus more emphasis on the internal efficiency of education. As was especially demonstrated by the World Bank using the rate-of-return analysis method based on the human capital theory, the rate of return is higher for primary education than for higher education. It raised the argument that more investment should be made in primary and secondary education during the 1980s.

In the 1990s the United Nations Development Programme (UNDP) set out a new development concept that stressed a shift from economic-centered development to human-centered development. By this new concept, human development came to be seen as the goal of development rather than a means of development. In addition, education was placed at the top of the international development agenda along with health, nutrition, safe water, and family planning.

These changes in the mainstream development approach also affected the approaches to educational development, especially after the World Conference on Education for All which was held in 1990 in Jomtien, Thailand. At this conference, the importance of basic education was internationally confirmed. Basic education was further emphasized in the Dakar Framework for Action, which was adopted at the 2000 World Education Forum held in Dakar, Senegal.

(b) Status of Science and Assistance in M&S Education

Around the turn of the 1990s, M&S Education gained new significance in light of the growing emphasis on basic education discussed above, and a fresh emphasis was placed on M&S Education. Scientific literacy was incorporated as part of basic education. The idea of science for all, rather than the traditional idea of science for the elite, became a socially accepted norm. Some donors revalued M&S Education. International assistance in M&S Education in basic education was increasingly delivered as part of support for improving teaching methods or teacher training.

(3) Education for Innovation: 2000s (up to the present)

(a) Approaches to Development and Education

Since the 1990s the world has experienced economic and social integration (globalization), along with rapid technological development and the increasing access to information. The gaps among countries as well as between the rich and the poor within a country are increasingly widening. Developing countries also become caught up in the flow of globalization. Therefore, they should not only make the most of the opportunities offered by globalization but also make efforts to build safety nets for the disadvantaged and the marginalized.

(b) Status of Science and Assistance in M&S Education

In this context, the roles of education are changing. In other words, improving the basic abilities of the society as a whole is more emphatically required, including that of each and every individual, as opposed to just for the elites as was previously done. M&S Education is attracting particular attention as a foundation for the current literacy, which not only consists of traditional methods such as reading, writing, and arithmetic, but also the information literacy which has become the key factor in order to deal with the information society of the globalizing world.

In addition, donors are increasing assistance to secondary and technical education because the number of children who have completed primary education has been rising as a result of improved efforts since the turn of the 1990s. Hence, developing countries have to pay more attention to secondary, technical, and higher education in order to accept those children who have completed primary education.

1-2. Developments and Characteristics of JICA's Assistance in M&S Education

Reviewing the history of JICA's assistance in basic education until the 1990s, it first assigned M&S Education Volunteers as part of the Japan Overseas Cooperation Volunteers (JOCV) Program in 1966. After that, during the 1970s, the major area of JICA's assistance turned to technology-related fields which mainly covered higher education and technical and vocational education and training (TVET).

The 1990 World Conference on Education for All, held in Jomtien, Thailand, provided a turning point. This international conference agreed to promote basic education as a common goal for the international community. Responding to this international consensus, JICA set up a series of study

groups on assistance in education. Efforts by these groups culminated in the 1994 report titled “Study on Development Assistance for Development and Education.” Since then, JICA has gradually expanded its assistance in basic education up until today.

JICA has implemented many cooperation projects with a focus on improving access, quality and management in the field of basic education. Among them, projects on M&S Education were positioned as those aimed at improving the quality of education, with most of these being for teacher training and the development of teaching and learning materials in M&S Education.

Assistance in M&S Education has been at the main of JICA’s technical cooperation projects in basic education. For example, of such projects in 2005, two out of every three (22 out of 33) were associated with M&S Education.

The reasons that M&S Education assistance has always been at the core of JICA’s basic education assistance can be grouped into those for partner countries and JICA. For the former, many developing countries believe that Japan excels in M&S Education, as always demonstrated in the findings of the international comparative studies such as the Trends in International Mathematics and Science Study (TIMSS[6]), and that this helped Japan to achieve economic development by rapid industrialization. Moreover, the achievements of JICA’s M&S Education assistance in 27 countries have convinced other donors as well as the partner countries that it is one of Japan’s areas of expertise.

For the latter, JICA has emphasized M&S Education in its assistance in education for three major reasons. First, arithmetic/mathematics and science are politically and culturally neutral compared with other subjects. Second, due to the nature of mathematics and science, which involve numerical formulas and universal scientific concepts, Japanese experts and volunteers who do not always have a strong command of medium languages such as English are less dependent on the language itself. Third, JICA has accumulated knowledge for M&S Education assistance through its practices at the school level in partner countries.

[6] TIMSS is a study to help countries all over the world improve student learning in mathematics and science. It collects educational achievement data at the fourth and eighth grades to provide information about trends in performance over time together with extensive background information to address concerns about the quantity, quality, and content of instruction.

2. Goals of JICA's M&S Education Assistance

2-1. Philosophy and Significance of JICA's M&S Education Assistance

(1) Significance of M&S Education for Character Building

The significance of general education for character building lies in that it helps people to acquire basic knowledge and skills needed to fulfill their responsibilities in their social and daily life as an individual and develop their full potential. The major roles of general education include: (i) developing people's ability and a positive attitude toward learning by acquiring different thoughts, knowledge, and information; broadening their academic horizons; and forming new knowledge and value; and (ii) nurturing the next generation by handing the intellectual heritage of the human race over to them and by teaching them how to utilize it. M&S Education plays important roles for students to acquire mathematics and scientific methods, attitudes, perspectives, and thinking, which are useful for problem solving; and nurturing a love of nature and developing a view of nature which are important for life (see Box 1).

(2) Significance of M&S Education for Development

Education helps people not only to improve their ability and acquire skills needed to live securely in natural and social environments, but also to build a foundation for improving their living conditions and livelihoods. In addition to supporting better living and security at the individual level, M&S Education also contributes to the economic, social, and cultural development of countries by promoting science and technology and industrialization, thus promoting human security and progress. The relationships between M&S Education and different development issues are discussed in detail below.

(a) Achieving a Secure Life: Seeking a Better Life and Security at the Individual Level

i) Improving health

Preventive education against diseases and epidemics is considered to be effective to achieve a secure life by reducing threats to health and life. Preventive education is largely based on scientific and mathematical knowledge. Scientific thinking and attitudes, along with rational judgment, facilitate appropriate applications of knowledge gained from preventive education.

ii) Mitigating natural disaster hazards and preventing associated environmental degradation

Large-scale natural disasters such as earthquakes and droughts are a major threat to people's lives and livelihoods. Although it is all but impossible to prevent them from occurring, it is possible to mitigate their impacts. Disaster education, safety education, and environmental education provide an effective means to that end; environmental education is important because environmental degradation is closely associated with natural disasters. These kinds of education are closely related to natural science. Therefore, efforts to promote and strengthen M&S Education contribute to raising people's awareness of nature and disaster preparedness and facilitating disaster prevention activities at the organizational and societal levels.

Box 1 Abilities and Attitudes That Can Be Acquired by Science Education

The Course of Study for Lower Secondary Schools, a set of official curriculum guidelines of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan, defines the overall objectives of science subjects, for instance, as "to develop attitudes and abilities to investigate scientifically, to foster scientific views and thinking, and to deepen the understanding of natural phenomena through enhancing students' interest in nature and letting them engage in observations and experiments with a clear purpose. " In other words, the goal is to help students to develop four kinds of abilities and attitudes as follows.

(1) Scientific methods

Scientific research methodology can be categorized into two kinds of methods. One is a method of acquiring new knowledge based on facts gained by observation and experiments. In a narrow sense, it may refer to the research method or heuristics. The other is a method of sorting out and organizing knowledge in a systematic way that already exists and/or that is not yet fully organized. This is also known as systematization.

(2) Scientific attitudes

(a) An attitude of observing things properly and objectively, free from subjective views, bias, and prejudice.
(b) An attitude of seeing things in an accurate, precise, lucid, and clear manner.
(c) An attitude of identifying relationships between things and even establishing laws for them by sharpening one's intellect and senses, concentrating one's thoughts, observing things patiently and meticulously, and searching for the truth.
(d) An attitude of being cautious, scrupulous, and thorough in doing things.
(e) An attitude of always having questions in mind and seeing things in a theoretical, rational, and critical manner.
(f) An attitude of courageously asserting what one thinks is right.

(3) Scientific perspectives

Science provides students with a foundation for a view of nature—or a particular way of perceiving nature. A view of nature encompasses *a view of matter*, a systematic way of perceiving forms of existence and movement of matter; *a view of life*, a systematic way of perceiving life phenomena and defining life: and *a view of the universe*, a particular way of perceiving the universe, as exemplified by the Ptolemaic theory and the Copernican theory.

(4) Scientific thinking

Scientific thinking refers to a process of establishing scientific knowledge, by dividing problems/phenomena into smaller parts, organizing and systematizing the facts and findings interrelated by a particular principle, and identifying common rules behind facts and findings collected about a phenomenon. This process of reasoning is applied to problem-solving. It takes the form of:

(a) Analytical thinking;
(b) Synthetic thinking;
(c) Inductive thinking;
(d) Deductive thinking; and
(e) Analogical thinking

Source: Compiled from the Ministry of Education, Culture, Sports, Science and Technology (1998); Terakawa (1997); and Mori (1996).

iii) Reducing poverty through improved agricultural productivity

Poverty and hunger in rural areas are among the high priority issues for the development of developing countries. Agricultural productivity improvement is essential to alleviate poverty and reduce hunger. To that end, vocational education and training and agricultural education play an important role. Since such education and training require knowledge about arithmetic/mathematics and science as a precondition, strengthening M&S Education allows students to acquire knowledge and skills needed in this sector.

iv) Developing basic skills for better access to employment opportunities

Creating employment opportunities for people living in poverty is one of the important duties of the state as it enables them to sustain and improve their living conditions. For this purpose, vocational education or technical training for groups of people is designed to improve their skills so as to gain better access to employment opportunities. M&S Education in particular plays an important role in vocational education and training for technical fields. Basic science literacy gained by M&S Education allows developing countries to provide sustainable vocational education and training on their own initiative. It can be achieved to maintain their levels of knowledge and sufficient skills to gain access to employment opportunities by organizing such an education system.

(b) Creating a Growing Society: Toward the Development and Stability of Countries

i) Developing science and technology

The more socio-economic development depends on advancements in science and technology, the more important it is for a country to develop human resources who support such advancements. First and foremost, nurturing researchers is crucial to improve the research capacities of higher education and research institutions, which are essential for promoting the development of new knowledge and technologies and creating innovations.

ii) Developing industries and promoting economic activity

It is necessary to nurture domestic small and medium enterprises and international trade and promote investment in order to vitalize economic activity. This can be achieved not only by developing legal regulatory frameworks and improving the climate for trade and investment, but also by developing industrial human resources to support these activities. Industrial human resources are developed by higher education and vocational education and training. This, however, is not possible without M&S education at the primary and secondary education levels. For this reason, M&S Education needs to be improved both quantitatively and qualitatively.

iii) Bridging the digital divide

The world is moving towards a knowledge-based society with the advancement of information and communications technology (ICT). There are growing concerns about the “digital divide”—a growing gap in access to opportunities for mastering and using ICT. In order to bridge the digital divide, developing countries need to meet a number of requirements. The governments of developing countries need to develop ICT networks, promote ICT, and build information networks. Citizens in developing

counties need to acquire—through education—both *information literacy*, the ability to choose and use relevant information, and *computer literacy*, the ability to use computers. In this context, more and more emphasis will be placed on M&S Education as it provides a basis for such literacy.

iv) Developing a labor force that is responsive to changes

The diversifying labor market in the face of rapid technological innovation and globalization calls for human resources who are committed to learning new knowledge and skills and responsive to technological innovations and changes in their working conditions. The need to create such a labor force highlights the importance of not only education and training in particular technical fields, but also knowledge and skills of arithmetic/mathematics and science, which forms the basis for such education and training.

v) Promoting conflict prevention and reconciliation

International and internal conflicts may result in the collapse of states and extreme poverty, thereby placing the people's lives in jeopardy. As an important means of preventing conflicts as well as promoting reconciliation and preventing conflict recurrence in the post-conflict phase, peace education is gaining further importance than ever before. Peace education is defined as "the process of promoting the knowledge, skills, attitudes, [and] values needed to bring about behavioral change that will enable children, youth, and adults to prevent conflict and violence, resolve conflict peacefully, and create peace" (JICA (2003c)). It includes, as important elements, a sound critical spirit, scientific and logical thinking, and tolerance for different values, which can be well developed in an effective manner through M&S Education.

Problem solving abilities, scientific thinking and attitudes, rational judgment, a sound critical spirit, and the formation of values, which are cultivated by M&S Education, enable people to improve their livelihoods and secure a stable life through skill development at the individual level. At the same time, they contribute to the economic, social, and cultural development of countries, laying the foundation for human security and the overall development of countries.

To date, JICA has provided M&S Education assistance in many developing countries. Given the importance of M&S Education discussed above, JICA will continue to proactively support M&S Education, which provides viable tools for achieving a secure life and creating a growing society.

2-2. JICA's Policies and Approaches to M&S Education Assistance: Future Directions

JICA has provided technical cooperation under the principle of supporting self-help efforts and human development. Recently, however, JICA has built on this principle and redefined the goal of its technical cooperation as "to support the ongoing process of enhancing the problem-solving abilities of developing countries by taking into account all the factors at the individual, organizational, and societal levels[7]."

In order to enhance the problem-solving abilities (or capacity) as a country, it is necessary to

[7] This new approach to technical cooperation is known as "capacity development (CD)." See JICA (2006b) for details.

foster the people who think, decide, and act on their own to deal with the challenges facing them. Ability to learn knowledge and experiences from others is also important. Developing such human resources requires the education sector to nurture students[8] who can identify their problems, collect and analyze the relevant information, deepen their thoughts through exchanging views with others, and take appropriate actions to solve the identified problems on their own. M&S Education provides an effective means to nurture such students. Based on this idea, JICA continues to place a strategic focus on M&S Education.

(1) JICA's Policy and Approach to M&S Education Assistance

(a) JICA's policy on M&S Education assistance

Nurturing such students as discussed above, requires, as an important element, student-centered lessons that encourage students to think, act, and find solutions independently, and to learn from others and then reflect on their learning. In fact, many developing countries are making a shift from the traditional ***teacher-centered*** approach to a ***student-centered*** approach. JICA has much to contribute to supporting such efforts to improve classroom lessons. To that end, it is important that JICA focus on ***teachers***, who play the most important role in the classroom.

The knowledge gained through practice in the classroom provides information that is useful to solve various educational issues not only for individual teachers but also for the education system as a whole, making "reforms from the classroom" possible. In order to enable the partner countries to sustain such reforms and retain their successful outcomes, JICA will also proactively support them in establishing a sustainable system and institutionalizing such a system.

i) Aim of JICA's M&S Education assistance: practicing student-centered lesson

What is essential in school education is the process where students gain ***awareness*** through independent thinking and practice so as to broaden their horizons and deepen their knowledge. This process, however, is not always given the proper respect in many developing countries. It is often the case that school teachers mechanically provide students with knowledge without paying adequate attention to their understanding levels and thinking development stages. Their teaching practices seem to be based on a misconception that students are passive receptors of knowledge. Such teacher-centered teaching may not support the learning of the students.

In order to transform teacher-centered teaching practices into student-centered ones, teachers should encourage students to identify and analyze problems on their own and then work with others to find solutions by accommodating their interests and enhancing their motivation to learn. The realities in many developing countries point to an urgent need for such a transformation (see Box 2).

[8] In this paper, "children," "pupils," and "students" are collectively referred to as "students."

ii) Focus of JICA's M&S Education assistance: transforming teachers' practices

JICA focuses on schools and classrooms where the actual learning of students occurs. Top priority is given to improving classroom ***lessons***, in which all kinds of educational issues are reflected, whether explicitly or implicitly. A detailed analysis of classroom lessons makes it possible to identify some of the essential educational issues for the school, the community, and beyond.

Among the essential components of a classroom lesson, that is, ***students, teachers,*** and ***teaching materials,*** teachers hold the key to improving the quality of school education. In general, new approaches and techniques in school teaching will always be practiced first by a few innovative and highly-competent teachers. Then they will gradually spread to other teachers. In the process, classroom lessons will be improved slowly but steadily at the school and community levels. Eventually, the quality of national education will be enhanced as a whole.

For this reason JICA's M&S Education assistance places particular emphasis on teachers. JICA believes in the potential of individual teachers in developing countries despite the extremely difficult conditions they find themselves in. Priority is given to in-service and pre-service training for teachers among other types of cooperation in this sector.

Box 2 Student-Centered Lesson

(1) Definition

A student-centered lesson is a lesson that involves a process in which students take lesson themes as their own and find solutions on their own by using their mind and body, and through interacting with others.[9]

(2) Supplementary explanation

It is important that students understand the contents of learning by their self-motivated activities (both mental and physical)—rather than by rote memorization alone—and acquire new knowledge, skills, values, and attitudes.

It is often the case that a lesson is judged student-centered based on the presence of conspicuous activities by students such as group activities and hands-on activities. However, such a presence does not necessarily provide a decisive criterion. Conspicuous activities by students may seem to indicate student-centeredness on the surface, but that does not always mean that students use their brain. Alternatively, when such activities are not present, active thinking may be going on deep inside their brain. Although group activities (and hands-on activities) provide an effective introduction to student-centered lessons, the goal of the student-centered approach is to encourage each student (within the group) to work on lesson themes of their own accord, thus stimulating the thinking process inside their brain with or without conspicuous activities. Student-centered lessons should be designed accordingly.

(3) Background

It was widely believed that children were like a white canvas waiting to be painted and that ***knowledge*** should be given from the outside. Currently, however, more and more educators are embracing the idea that children make sense of the world around them by approaching it by using their knowledge and experience. According to this idea, ***learning***—the process of acquiring new ***knowledge***—involves commitment and activities on the part of the learner as essential elements. For this reason, ***lessons***, which play a central role in ***learning*** at school, need to place students at the center.

Therefore, teachers should act as facilitators who support self-motivated learning by students, rather than knowledge providers. Student-centered lessons should meet the following conditions:

[9] "Others" refers not only to people, but also to other things, such as textbooks and study guides.

(a) Students take lesson themes as their own and use their own brain to work on such themes. For this to happen, teachers should select lesson themes that stimulate students' interest and motivate them to think on their own, by including those closely associated with their surrounding environments;
(b) Lessons involve mental and physical activities by students;
(c) The curriculum should build on what has already been learned and at the same time involve interesting and attainable challenges; and
(d) These challenges are in line with teaching objectives.

This transformation process will not be possible unless school teachers change their mindsets and attitudes to improve their teaching methods. The goal here is to provide lessons that are more accessible to students; lessons that are arranged with interaction with students; lessons that allow students to learn and think on their own; and lessons that encourage students to work with others to solve problems.

These lessons enable students to learn basic knowledge and skills more effectively and acquire logical and scientific ways of thinking and viewing. What students have learned and acquired will be put to good use in their daily lives. In addition, it will help students to overcome difficulties, improve the standards of living for themselves and their families, and eventually build a better community, a better country, and a better future.

(b) JICA' s Approach to M&S Education Assistance

Japan has tried many methodologies to improve the practices of teachers at home. JICA has decided that two methodologies are most effective and sustainable in addressing the problems that developing countries face in M&S Education. The two methodologies, namely, ***lesson planning*** and ***lesson study***[10] are central to JICA's approach to M&S Education assistance.

i) Introducing and entrenching lesson planning: lesson structuring

Curricula play important roles in establishing the standards for school education in a country. In order to appropriately implement them, it is necessary to introduce systematic thinking into the education processes and manage the progress of educational activities. Lesson planning allows teachers to accurately assess the state of affairs, devise effective and practical ways of teaching in order to put them into practice in a systematic manner.

In lesson planning, based on the curriculum which are designed for each educational level (primary, secondary, or higher), teachers develop annual plans, unit plans, and lesson plans in order to effectively achieve the objectives of the curriculum. Taking account of the situations students and the school find themselves in, each plan analyzes the teaching materials and is given shape with specific learning targets and detailed teaching content for students to effectively learn. Teachers should make sufficient preparations for better lessons, including devising questions for students carefully in line with such learning targets and detailed content, and anticipating their responses. Without such efforts, teachers would not be able to accept students' ways of thinking and put them to good use in class. Repeating this cycle for each class enables teachers to develop practical teaching skills (see Box 3).

[10] The kind of lesson study adopted in M&S Education projects supported by JICA is essentially the same in concept as the one widely practiced in Japan. Yet what form it takes and how it is practiced vary depending on the situations and conditions of the partner countries and to what extent it is introduced and entrenched. Such various forms are collectively referred to as "lesson study" in this paper, although it is more precise to refer to them as the "training method based on lesson study."

In addition, designing lessons systematically calls for teachers to have a deep understanding of teaching content and practical teaching skills. For this reason, JICA-assisted in-service and pre-service training for teachers focus on these requirements.

Box 3 Lesson Planning

(1) Definition

Lesson planning is the kind of educational planning that enables effective and efficient implementation of a systematic curriculum that has carefully selected and categorized the teaching content.

(2) Supplementary explanation

Lesson planning generally consists of three components: ***an annual teaching plan, a unit plan***, and ***a lesson plan***. These plans for each subject are compiled and fleshed out in that order. This is a method of designing lessons according to the teaching plan, and is called as ***"lesson structuring."***

- *Annual plan*: an upper-tier plan for each subject and grade (compiled on the basis of the Course of Study for each subject).
- *Unit plan*: a middle-tier plan that divides each unit into subunits and allocates lesson hours to each subunit so that each unit is taught in a systematic manner. It often shows how the units are related to those that have been or will be taught in other grades.
- *Lesson plan*: a lower-tier plan designed to implement the unit plan. It contains a detailed time allocation plan, lesson procedures, and a blackboard writing plan for each class.

In lesson planning, planners divide the curriculum for each educational level (primary, secondary, or higher) by grade and then develop an annual plan, a unit plan, and a lesson plan in that order. Each plan is fleshed out with specific learning targets and detailed teaching content. In developing a lesson plan, teachers need to assess the progress and other conditions of the students and analyze teaching materials so that students make the most of the class. Teachers should make sufficient preparations for better lessons, including devising questions for students carefully in line with such learning targets and detailed content, and anticipating their responses. Without such efforts, teachers would not be able to accept students' ways of thinking and put them to good use in class. Repeating this cycle for each class enables teachers to develop practical teaching skills.

Source: Compiled from JICA (2004g).

ii) Introducing and entrenching lesson study: learning teachers

It is important that teachers themselves evaluate the lessons they deliver and identify opportunities for improvements of their own accord. Such efforts help teachers to improve not only individual lessons, but also their teaching skills as a whole. They also provide teachers with a source of information to revise the curriculum when necessary. Aiming at supporting such initiatives by teachers, many JICA-assisted projects adopt the methodology known as "lesson study."

Lesson study refers to a methodology involving the principle of ***Plan-Do-See*** for improving classroom lessons through peer collaboration, whereby teachers work together to study teaching materials to be used, deliver a lesson with such materials, and review it to discuss how to improve the lesson (see Box 4). Learning from other teachers' experiences and practices using actual lessons allow teachers to develop knowledge and skills of utilizing teaching materials effectively and of assessing

and understanding the students including their readiness, misconceptions, etc. This supports a gradual improvement of classroom lessons, and by making continued efforts, the teachers themselves can keep learning. Those self-motivated teachers will be able not only to improve individual lessons at the classroom level, but also to deal with other kinds of educational problems at the school level in a sustainable fashion.

Lesson planning and lesson study complement each other in improving education as a top-down approach and a bottom-up approach, respectively. JICA is well served to address both for more effective education development.

Box 4 Lesson Study

(1) Definition

Lesson study refers to a methodology involving the principle of ***Plan-Do-See*** for improving classroom lessons through peer collaboration, with its focus exclusively on lessons themselves. In this methodology, a teacher gives a lesson based on a lesson plan in the presence of observers (peer teachers in most cases) and, after the lesson, the teacher and the observers discuss it to identify opportunities for improvement (see JICA (2005i). ch. 13.).

(2) Supplementary explanation

The key objective of lesson study and/or the level of experience of the participating teachers determine which of the components *("Plan," "Do,"* and *"See"*) is stressed most. For example, the process of *"Plan"* may be emphasized more than the other two when the key objective is to encourage a group of teachers who do not usually make lesson plans to do so. Such encouragement may take the form of teaching them how to plan lesson in collaboration with peer teachers.

The process of *"Do"* may be stressed more when the demonstrating teacher introduces a new teaching method, and the "See" process is more like a forum in which they explain their intentions.

The process of *"See"* may be given more time than the "Plan" process when a group of teachers with certain levels of experience and skill want to learn more flexible and responsive teaching skills or broaden their frame of reference in order to give more student-centered lessons where even unexpected responses from students are put to good use in class.

Source: Compiled from JICA (2004g).

(2) Future Directions for JICA's M&S Education Assistance

In recent years, more and more developing countries have been requesting M&S Education assistance of Japan. In order to better accommodate these requests, JICA will further strengthen and promote assistance in M&S Education on two pillars: expanding the scope of M&S Education assistance beyond its current limits and disseminating the knowledge acquired through years of M&S Education assistance, while making the most of Japan's experience and comparative advantages in this field (see Box 5).

Box 5 Japan's Comparative Advantages in M&S Education

M&S Education assistance has played a central role in Japan's international cooperation in education. Japan's comparative advantages in M&S Education are described below.

(1) Economic development achieved by rapid progress in science and technology

Though not endowed with natural resources, Japan successfully achieved economic development in a relatively short period from the rubble of the Second World War. Behind this remarkable development were the government policy initiatives that aligned education, especially in science and engineering, with the development of science and technology (S&T) and highly efficient human resources. This experience has been attracting particular attention from many developing countries with regard to M&S Education in Japan. For this reason, many of their requests for development assistance in education from Japan are for M&S Education assistance.

(2) World-class M&S Education

The current position of Japanese S&T in the world is supported by the fact that Japan's M&S Education excels in the world. This fact is demonstrated by the international comparative studies on achievements such as TIMSS, which interests many developing countries in M&S Education of Japan.

(3) Practical experiences at the classroom and school levels

Apart from the policy initiatives that have contributed to improving M&S Education at the national level, Japan has had an unbroken tradition of continuous efforts by teachers to improve their lessons (lesson study) at the grassroots level since the Meiji Era (1868-1912). In an effort to give lessons that are understandable to students, teachers have been trying to associate "school knowledge (teaching content)" with "everyday knowledge (wisdom for everyday living)". These practical experiences at the classroom and school levels, which are rather unique to Japan, provide a viable tool for promoting education development in developing countries today.

(4) Availability of quality textbooks and guidebooks

Generally, textbooks in Japan are concise but inclusive and systematic. Since they are built on what is already learned, they are highly evaluated in terms of learning continuity as well. Likewise, guidebooks for teachers in Japan are user-friendly. They include information not only on questions, answers and explanations on how to solve the questions, but also on how to organize the lessons and content knowledge necessary for teachers to deliver the lessons.

(5) Experience of adopting ways of thinking different from the endogenous one

Historically, Japan, once an underdeveloped country, successfully adopted Western ways of thinking (as highlighted by logical thinking, democracy, and liberalism) different from the traditional Japanese way of thinking (and culture), and put them to effective use in developing itself. In relation to M&S Education, Japan made a successful transition from Japanese mathematics to Western mathematics and proactively adopted modern S&T. In this way, Japan, with its strong government leadership, domestically developed the current educational system of arithmetic/mathematics and science. Such experiences, which are not found in many other donor countries, provide a valuable hint for education development in developing countries.

(a) Expanding the Scope of M&S Education Assistance

i) From development to scaling up

Effective approaches to assist M&S Education are taking shape, in light of the accumulation and analysis of outcomes of JICA's activities in M&S Education. JICA pursues, by utilizing the approaches, two aspects of M&S Education assistance: the institutionalization of project outcomes in the partner country and their scaling up in neighboring countries.

In relation to the first aspect, JICA increases its support for disseminating various kinds of knowledge and expertise gained from pilot projects in other parts of the partner country so that they will take root in the country (institutionalization).

As for the second aspect, JICA plans to put more emphasis on replicating the outcomes of successful projects in neighboring countries that face similar problems and have much in common in terms of linguistic, cultural, and social aspects ("extending projects region wide"), based on the concept of the south-south cooperation.[11] Arithmetic/mathematics and science are more applicable to such extension than other subjects. This is because they are more characterized by their universality, rationality and systemicity, which makes the content of learning less likely to be influenced by the context of each country. In addition, the region-wide program promotes dialogue and exchanges of views among the countries as well as a mutual collaboration, as a consequence, regional dynamism will be created. This can be utilized for further promotion of education development within each country.

ii) From M&S Education to the basic education sector as a whole

・***From M&S Education to education development in general.*** Historically, JICA's assistance tended to focus on M&S Education. Yet many of the outcomes of M&S Education assistance can be applied to other subjects and education development issues, including experiences and knowledge regarding improving the managerial capacity of local government officials and school heads. JICA will make further efforts to organize such outcomes, share them with the stakeholders, and apply them to the process of education development in developing countries in order to improve the quality of education.

・***From project to program.*** As aid coordination and sector-wide approaches are gaining currency, it is important to position M&S Education assistance under JICA's Technical Cooperation Project scheme explicitly in the education policies and programs of partner countries.

Education activities are comprised of many components, including pre-service and in-service training for teachers, development and revision of curricula, production and distribution of textbooks, provision of school facilities and equipment, and improvement of the educational environment surrounding students. Moreover, these components are interrelated with one another. For these reasons, it is necessary to approach many of these components comprehensively at the same time to improve the quality of education.

For example, improving the quality of M&S Education requires efforts at various levels. It is likely that activities to improve class lessons by teacher training alone will have only limited and short-term effects. In order to sustain, spread, and develop such activities, other efforts should be made at the same time. Among them are institutionalizing teacher training, strengthening teacher training courses, improving curricula, developing teaching materials and tools, developing teacher's guidebooks, and improving school administration. It is also crucial to develop mechanisms that increase the sustainability of assistance and

[11] In fact, Japan has already launched two region-wide programs in Africa and Latin America based on the concept of south-south cooperation. One is a network program implemented by the SMASSE in Western, Eastern, Central, and Southern Africa Association (SMASSE-WECSA), based on the Project on Strengthening of Mathematics and Science in Secondary Education (SMASSE) in Kenya. The other is the Regional Program for Mathematics Education in Central America and the Caribbean (region-wide PROMETAM), based on the Project for the Improvement of Teaching Method in Mathematics in Honduras (PROMETAM).

support self-driven, sustainable education development in the partner countries. Approaching all these components simultaneously requires JICA to implement a wider program rather than a stand-alone project, to place it properly in the partner country's education sector as a whole with attention given to JICA's comparative advantages, and to coordinate with other donors (see Box 6). In this way, JICA needs to provide assistance more flexibly than before and extend its scope beyond the boundaries of M&S Education as necessary.

Box 6 From Project to Program

Project for the Improvement of Teaching Method in Mathematics in Honduras (Proyecto Mejoramiento en la Enseñanza Técnica en el Área del Matemática: PROMETAM) [Phase I: April 2003 - March 2006; Phase II: April 2006 - March 2011]

In Honduras, education development has been underway since 2003 under the EFA-FTI[12] (Education for All-First Track Initiative) Plan that the Ministry of Education developed in line with an international consensus. This plan contains three major numerical targets as follows: (i) a primary education completion rate of 100%; (ii) a primary education completion rate within 6 years of 85%; and (iii) a scoring rate on the designated standard test in mathematics and Spanish for 6th graders of 70%. A number of donors support the Ministry of Education with regard to these targets. Under the initiative by the ministry, such support is coordinated at the education sector donor meeting known as MERECE, which was established in 1998. With 13 regular members and others, MERECE serves as a forum for effective and efficient aid coordination.

In 2003 JICA launched the Project for the Improvement of Teaching Method in Mathematics (PROMETAM) in Honduras. Its main objectives were to reduce grade repeaters due to poor performance in arithmetic and to improve the arithmetic teaching skills of teachers. Building on the 13-year experience of JOCVs in supporting arithmetic education in Honduras, PROMETAM has developed teacher's guidebooks and student's workbooks with the Ministry of Education and local educational universities as the project counterparts. Both closely follow the new curricula, and the teacher's guidebooks are designed to allow teachers to give proper lessons at an appropriate pace. The educational universities have used their in-service training for teachers and other occasions to promote these guidebooks and workbooks, thus developing local human resources.

Concurrently, JICA Honduras Office consulted with the Ministry of Education and other donors. As a result, PROMETAM was recognized as two important components of the EFA-FTI Plan, namely, "teaching materials development" and "teacher training, with regard to arithmetic"—one of the strategic subjects for the Plan. On account of JICA's commitment to the partner country's program, the Ministry of Education authorized these teaching and learning materials as Honduras' government-designated materials. Sweden, Canada, and other donors provided funds for printing and distributing them. In 2005 these PROMETAM-developed materials were distributed nation-wide, including 1.3 million copies of student's workbooks, and some 40,000 copies of teacher's guidebooks.

Since 2006 efforts have been made to ensure that these materials would take root in the classroom in Honduras. In addition, JICA provides region-wide assistance aimed mainly at developing human resources in mathematics education in five countries in Central America and the Caribbean, including Honduras.

[12] FTI is a global partnership between donors and developing countries to ensure accelerated progress towards the Millennium Development Goal of universal primary education by 2015.

・ ***From technology transfer to capacity development.*** JICA now embraces the concept of capacity development (CD), which emphasizes the need to help developing countries to improve their problem-solving abilities (capacity) rather than technology transfers. JICA is committed to sustaining, developing, and spreading CD efforts by institutionalization, and to building mechanisms that allow developing countries to achieve self-reliant and sustainable education development. In this context, JICA takes an inclusive approach, combining various cooperation activities at individual, organizational, and societal/institutional levels in an optimal mix so that partner countries can achieve sustainable and self-reliant development (see Box 7).

Box 7 Technical Cooperation as Capacity Development Assistance

Strengthening of Mathematics and Science in Secondary Education Project (SMASSE) in Kenya [Phase I: July 1998 - June 2003; Phase II: July 2003 - June 2008]

Kenya placed particular emphasis on developing human resources in science and engineering for its industrialization. For Kenya, improving the quality of M&S Education was a major challenge. In 1998 the Kenyan government launched the Strengthening of Mathematics and Science in Secondary Education Project (SMASSE) in support with JICA. SMASSE was designed to strengthen the skills of science and mathematics teachers through in-service training. In order to achieve this, a cascade system (the transmission of lectures from central to local leaders) at the central and local levels was established.

JICA defines capacity as "the ability of developing countries to solve problems on their own" and regards it as a "complex of elements including institutions, policies, and social systems." Likewise, JICA defines capacity development as "the ongoing process of enhancing the problem-solving abilities of developing countries by taking into account all the factors at the individual, organizational, and societal levels." It concludes that "technical cooperation should provide a means to support the capacity development (CD) of developing countries." (JICA (2006b)).

SMASSE is based on the idea that improving M&S Education demands not only enhancing the abilities of individual teachers, but also developing an organization or institution that allows them to demonstrate their enhanced abilities. In that sense, the concept of CD is well reflected in SMASSE. The following three examples concretizes the core ideas of SMASSE.

(a) Creating an enabling environment for teachers

SMASSE created an enabling environment where teachers can demonstrate their enhanced abilities. For example, when SMASSE tried to institutionalize in-service training, it did not limit its focus only to teachers but also explained its intention to school head associations so that school heads would support the changes in teachers.

(b) Adopting an inclusive approach

SMASSE adopted an inclusive approach. For example, when local stakeholders in Kenya tried to create a "system designed to improve teachers' skills to conduct lessons in a sustainable manner," they also considered what step should be taken to maintain such a system once it had been created. The actual steps they took include:

i) identifying the capacity elements that should be strengthened at the individual, organizational, and societal levels of the central government; the districts; and schools/parents;
ii) involving school heads and parents;
iii) strengthening organizations at various levels, from local government organizations that directly influenced schools to national research organizations; and
iv) promoting institution building in relation to these organizations.

(c) Nurturing ownership and self-motivated engagement of the stakeholders

SMASSE provided many opportunities to nurture ownership and self-motivated engagement of the stakeholders in Kenya. First, the project created mechanisms designed to motivate each stakeholder. Second, SMASSE encouraged the stakeholders to face reality and have a sense of awareness. Third, JICA experts limited their roles as facilitators in all these activities, and when necessary, waited patiently for the stakeholders in Kenya to make decisions or take actions. Fourth, SMASSE created a fund that collects a portion of the lesson fees for schools and finances teacher training at the district level in order to provide and manage such training in a sustainable manner.

As in the above, SMASSE has successfully put into practice the idea of CD, owing to the two unique aspects of this project. The first aspect is its comprehensive approach, focusing not only on the individual teachers but also on the environment surrounding them by taking into account the regulations and educational systems. The second aspect is that JICA had stayed in the background of the activities in order to foster the ownership of the partner country.

(b) Disseminating the Knowledge Acquired through Years of M&S Education Assistance

i) Collecting, processing, and utilizing knowledge

Most of the experiences and knowledge gained and lessons learned from JICA's M&S Education assistance have been derived from practice in the field. It is important that JICA collect, process, and organize the knowledge gained from practical experiences in the world so that JICA staff, experts, and other stakeholders can utilize it.

It is also necessary to develop a system whereby practical experiences at the classroom and school levels and the outputs of universities and research institutions in Japan can be put to good use in JICA's activities in the future.

ii) Dissemination of knowledge: taking an active part in international and regional networks

JICA takes further steps for better contribution to the international community. It will analyze and organize the kind of knowledge discussed above so that it is also made available to multinational and bilateral donors and developing countries.

To that end, JICA takes an active part in international networks such as EFA-FTI and in regional networks such as the Association for the Development of Education in Africa (ADEA).

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Appendix 1: Current Status and Challenges for Mathematics and Science Education (M&S Education) in Developing Countries

Many children in developing countries are denied the opportunity to go to school, and those who are able to go may end up dropping out. Even if they are fortunate enough to graduate from school, they still may not have adequate academic abilities. These are among the various challenges in the education sector that developing countries are faced with.

As their policy documents stress the importance of M&S Education, many developing countries face the problem of inadequate human resources in science and engineering to support economic development. Results of examinations for entrance and promotion in most developing countries have reported that most students who fail these examinations have difficulty in learning arithmetic/mathematics and science. These students remain in the same grade or drop out of school, resulting in inefficient use of the education budget and increasing social costs. These problems may hinder the educational development of these countries.

Mathematics and science teachers with experience working in developing countries as JOCVs, JICA experts, and others also have pointed out the problems with M&S Education in developing countries.

Some major obstacles to M&S Education in developing countries at the classroom and school levels are listed below.

(1) Challenges Associated with Teachers

(a) There are a number of factors that make it difficult for developing countries to secure an adequate number of mathematics and science teachers who are highly qualified. Since it is often the case that, in the teacher training courses, fewer students major in arithmetic/mathematics education and science education compared with the other subjects, a relatively large portion of those who have become teachers have difficulty in teaching these subjects. This is largely associated with the fact that many students hesitate to enter into the teaching profession in most developing countries due to the low social status and low salary of teachers. To make matters worse, those who major in arithmetic/mathematics and science education end up with well-paid jobs in private businesses or become teachers in other countries.

(b) Due in part to both the inadequate education in teacher training courses and insufficient opportunities for in-service training, many teachers are unable to acquire school-subject knowledge and teaching skills that are sufficient to deliver effective lessons. Note that teaching practices have a stronger influence on the level of students' understanding in developing countries where the opportunities to experience "science and technology" in everyday life are rather limited.

(c) In some cases developing countries tend to introduce new teaching methods nationally under the strong leadership of the government, without adequately studying the methods or taking into account the situation of the students and the capacity of the teachers. In such a case, those methods are likely to work less effectively than expected in the classroom.

(d) The effects of teacher-centered teaching of the knowledge transfer type, which has been practiced for years, linger, making it rather difficult to conduct student-centered lessons or lessons that accommodate the situation (development stage/readiness) of the students.

(2) Challenges Associated with Teaching/Learning Materials, Facilities, and Equipment

(a) The actual conditions in the classrooms in many developing countries are not conducive to appropriate lessons. It is often the case that workbooks, textbooks and other supplementary materials are not distributed to each teacher or student. The situation is the same with guidebooks and reference books for teachers.

(b) Science lessons are often conducted with experiments to help students deepen their understanding. Schools in developing countries, however, are generally not well equipped with laboratory instruments and equipment due to financial constraints and a lack of infrastructure such as electricity, limiting the opportunities for laboratory experiments and practice.

(3) Challenges Associated with the Curricula

(a) Compared with other school subjects, arithmetic/mathematics and science are more systematic in nature. They start with basic knowledge and skills and move on to the next ones according to what students have previously learned. This makes it essential that the units are properly linked and sequenced. A poorly organized curriculum will have tremendously adverse effects on both the students and teachers, making it difficult for students to understand.

(b) It is difficult for teachers in developing countries to complete curricula within the predetermined class hours because it is often the case that curricula are overcrowded with content which has not been carefully selected, and that relatively limited class hours are allocated. The situation becomes worse when the curricula include more topics accompanying the ongoing development of science and technology.

(c) The linkage between the contents of subjects with the students' daily lives is often weak because the mechanism for meeting local needs is inadequate. The local capacity to develop their own textbooks is often insufficient. In some cases, the textbooks of the former colonial powers, as well as their curricula, are used without being revised properly.

(4) Challenges Associated with the Educational System

(a) Since in-service teacher education and training is not fully institutionalized in many developing countries, it is difficult to provide coherent teacher education, which makes it difficult for teachers to improve their knowledge and skills of teaching.

(b) The processes or mechanisms needed to successfully implement the national curriculum are often weak or non-existent. The underlying purpose and even educational objectives of the curriculum have not been properly understood by teachers on the ground, which poses an enormous challenge. Textbooks, which are the embodiment of the national curriculum in many countries, are not always systematically written.

(c) Examinations for students, the purpose for which range from screening and improving teaching to personnel management, are not always consistent with the national educational goals, especially in such aspects as the examination system and content.

(d) The education systems often place exclusive emphasis on the outputs of education such as achievement test performance, disregarding the processes of education. For example, classroom lessons, which are an important part of the educational processes, are not fully evaluated and are not often open to peer teachers and others.

(5) Other Challenges

(a) Differences in context between developed and developing countries

Arithmetics/mathematics and science require the use of technical terms in order to explain abstract ideas. Since many of those terms have no equivalents in local languages, it is often the case that scientific expressions used in developed countries can not be introduced as they are. The education provided in each community is so deeply rooted in the values, ways of thinking, customs, and religion(s) of that community or its ethnic group(s) that it may conflict with the characteristics of arithmetic/mathematics and science such as objectivitiy, sequentiality, systemicity, and abstractness.

(b) Lack of scientific recognition in everyday life

"Science" is rather irrelevant to everyday life as there are few opportunities to link the former with the latter in developing countries.

Appendix 2: Facts and Figures about JICA's M &S Education Assistance

JICA delivers assistance in M&S Education via a number of its schemes: *Technical Cooperation Projects* for integrated support; *Japan Overseas Cooperation Volunteers* for dispatching M&S Education volunteers; *Acceptance of Technical Training Participants* for training in Japan and third countries, and *Grant Aid* for the construction of facilities and provision of equipment.

This appendix reviews JICA's M&S Education assistance in these schemes, with a focus on such aspects as objectives, activities, developments, modalities, and characteristics. The data provided is based on JICA's performance database.

1. Technical Cooperation Projects

"Technical Cooperation Projects" constitute one of JICA's main overseas activities. In a typical technical cooperation project, JICA works with the partner country to develop a cooperation plan according to the Project Design Matrix (PDM) while taking the local conditions into account. Cooperation plans aim to produce specified outputs within a specified period with a mix of such aid components as the dispatch of experts, the acceptance of training participants, and the provision of equipment, while also taking advantage of the knowledge, experiences, and skills of the two countries. Once this cooperation plan (generally based on PDM) is agreed upon between Japan and the partner country, the project is implemented and managed in an integrated manner. Technical Cooperation Projects cover a wide spectrum of development sectors, ranging from infrastructure development, education, and health to agriculture, economic policy, and the environment.

The first project in M&S Education was the Package Cooperation/Science and Mathematics Education for Manpower Development Project (SMEMDP), which was launched in the Philippines in 1994. Since then, JICA has supported a total of 35 projects in 27 countries in this field (as of 2005) (Chart 2). With the main focus on in-service training (INSET), these projects have covered an array of pre-service training (PRESET), guidebook development, school management and curriculum and textbook improvement. Projects in M&S Education account for two-thirds of the projects in basic education (Chart 1).

Chart 1: JICA's Technical Cooperation Projects in Basic Education and M&S Education (Number of Technical Cooperation Projects Launched)

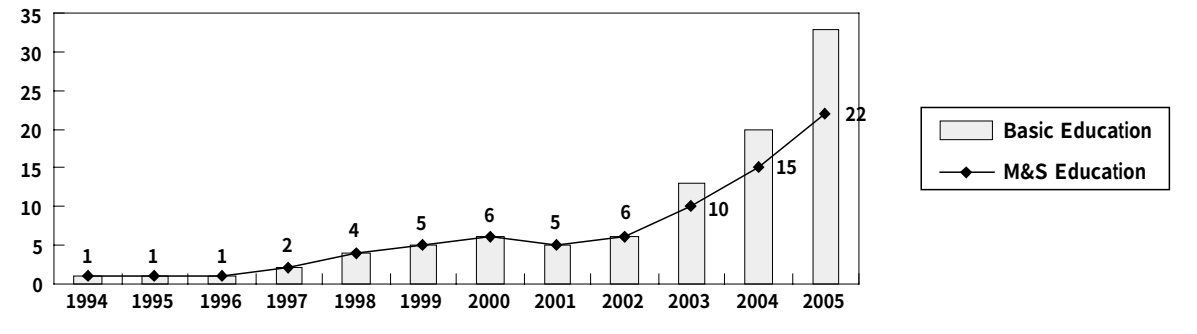
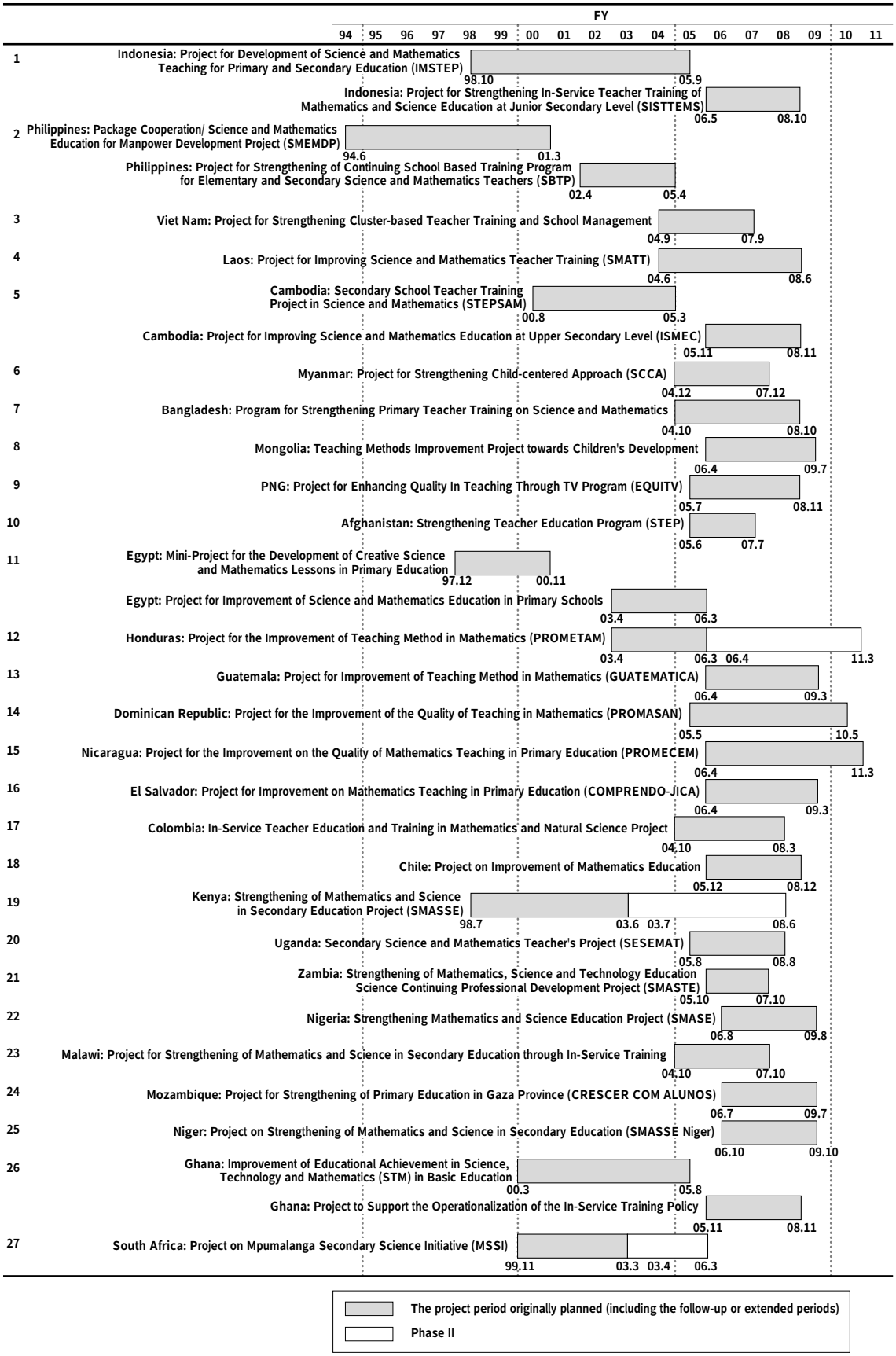


Chart 2: List of Technical Cooperation Projects in M&S Education (with Project Periods)



2. Dispatch of M&S Education Volunteers under the JOCV Program

Historically, the Japan Overseas Cooperation Volunteers (JOCV) Program has placed great weight on the education/culture sector (representing 45%). Volunteers in M&S Education (teachers of science/mathematics, mathematics, and science) account for about 15% of those in education and culture. Some of them teach at primary, middle, and high schools, while others are assigned to teacher training schools and education resource centers where they engage in developing teaching materials and training for teachers. While M&S Education volunteers have been dispatched to regions all over the world, a significant portion of them have been sent to English-speaking countries in Africa.

M&S Education volunteers were first dispatched in 1966. Since then, a total of 2,146 such volunteers have been dispatched to 57 countries as of 2006 (Charts 3, 4).

M&S Education volunteers are characterized by their activities at the grass-roots level. Many of them are assigned to local schools where they give lessons just like their local colleagues. Recent years have seen examples of M&S Education volunteers working in coordination with facility construction and equipment provision under grant aid and even with technical cooperation projects (Honduras, Bangladesh, and so on).

Chart 3: Changes in the Number of M&S Education Teachers Dispatched under the JOCV Program (FY1995 - FY2005)

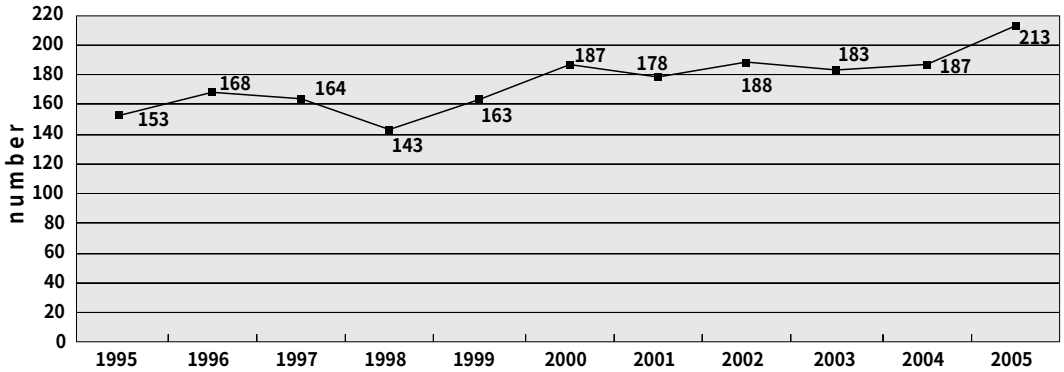


Chart 4: Number of M&S Education Teachers Dispatched under the JOCV Program by Country

As of June 1, 2006		Secondary Mathematics or Secondary Science&Mathematics	Secondary Science	Primary School	Total
Asia	Bangladesh	39	1	0	40
	Bhutan	3	0	0	3
	Cambodia	2	0	0	2
	China	1	0	0	1
	Indonesia	7	0	0	7
	Laos	5	0	0	5
	Maldives	3	0	1	4
	Malaysia	5	0	0	5
	Nepal	115	7	0	122
	Pakistan	1	0	0	1
	Philippines	84	5	0	89
	Sri Lanka	4	1	0	5
	Thailand	1	0	0	1
Latin America	Bolivia	9	2	0	11
	Colombia	2	1	0	3
	Dominican Republic	7	0	10	17
	Ecuador	4	0	0	4
	El Salvador	8	5	0	13
	Guatemala	5	1	7	13
	Honduras	28	14	86	128
	Jamaica	4	5	0	9
	Mexico	2	0	0	2
	Nicaragua	5	1	5	11
	Panama	9	10	0	19
	Paraguay	14	11	2	25
	Peru	3	1	0	4
	St. Lucia	13	0	5	18
	St. Vincent	4	0	0	4
Middle East and Africa	Benin	2	0	0	2
	Botswana	2	0	0	2
	Ethiopia	3	2	0	5
	Gabon	1	0	0	1
	Ghana	340	26	0	366
	Jordan	1	0	0	1
	Kenya	334	0	0	334
	Liberia	45	2	0	47
	Malawi	156	0	0	156
	Mozambique	14	0	0	14
	Namibia	4	0	0	4
	Niger	7	1	0	8
	Rwanda	1	0	0	1
	South Africa	18	0	0	18
	Tanzania	171	0	0	171
	Uganda	22	0	0	22
	Zambia	195	13	0	208
	Zimbabwe	2	2	0	4
Eastern Europe	Bulgaria	1	0	0	1
	Poland	1	0	0	1
Oceania	Fiji	11	0	0	11
	Marshall	26	3	23	52
	Micronesia	16	0	2	18
	Palau	7	1	1	9
	PNG	40	0	0	40
	Samoa	21	0	1	22
	Solomon	15	16	0	31
	Tonga	27	0	0	27
	Vanuatu	4	0	0	4
Total		1801	130	143	2072

3. JICA's Training Programs (Training in Japan and Third-Country Training)

JICA's Training Programs are largely divided into training in Japan and Third-Country Training.

(1) Training in Japan

"Training in Japan," a JICA program with a history of more than 50 years (since 1954), targets administrators, engineers/technicians, and researchers who play a pivotal role in the development of developing countries. Taking advantage of Japan's expertise and experience, this program offers training in the knowledge and skills requested by partner countries.

In M&S Education, this program has accepted partner country counterparts for training in JICA's partner organizations in Japan as part of the projects listed in Chart 2 (a total of 364 training participants between FY2004 and FY2006). In addition, the program has also provided group training courses for participants from two or more partner countries. "Practice of Science Education for Secondary School" and "Country Focused Training Course in Primary Education (Southwest Asian Countries)" are among such courses (Chart 5).

(2) Third-Country Training

Developing countries that have received development assistance from Japan serve as hubs for the Third-Country Training Program. This program takes advantage of these countries' human resources that have been developed by Japan's technical cooperation. It invites training participants from neighboring countries that share similar social or cultural environments with the help of other technical and financial assistance from Japan. In implementing the program, JICA makes good use of the knowledge and experiences gained from its earlier activities.

This program is implemented when the relevant resources are not available in Japan or when it is proved to be effective if implemented in a third country. Under the program, the number of participants in M&S Education has been on the rise since 2003.

One of the examples of Third-Country Training Program in the field of M&S Education is implemented as part of SMASSE in Kenya, providing training for educators from other African countries. In this way, the outputs of technical cooperation projects are spreading across national borders to neighboring countries in the form of the south-south cooperation (Chart 6).

Chart 5: Participants in Thematic Training Courses for M&S Education in Japan (between FY2000 and FY2005)

FY	Course title	Participating country (Number of participants)	Consignment/training institution
2000	Country Focused Training Course in Primary Education (Southwest Asian Countries)	Bangladesh (2), Myanmar (2), Sri Lanka (2), Pakistan (2): Total (8)	・Consignment: Northern Regions Center ・Training institution: Obihiro Board of Education; Hokkaido University of Education
	Practice of Science Education for Secondary School	Malawi (1), Ethiopia (1), Zambia (1), Tanzania (1), South Africa (1), Uganda (1): Total (6)	・Consignment: Ministry of Education, Culture, Sports, Science and Technology (MEXT) ・Training institution: Faculty of School Education, Hiroshima University (now the Faculty of Education, Hiroshima University)
2001	Country Focused Training Course in Primary Education (Southwest Asian Countries) II	Bangladesh (2), Myanmar (3), Sri Lanka (2), Pakistan (2): Total (9)	・Consignment: Northern Regions Center ・Training institution: Obihiro Board of Education
	Practice of Science Education for Secondary School	Malawi (1), Tanzania (1), Uganda (2), Zimbabwe (1), Lesotho (1): Total (6)	・Consignment: MEXT ・Training institution: Graduate School of Education, Hiroshima University
2002	Country Focused Training Course in Primary Education (Southwest Asian Countries) II	Bangladesh (3), Myanmar (2), Sri Lanka (1), Pakistan (2): Total (8)	・Consignment: Northern Regions Center ・Training institution: Obihiro Board of Education
	Practice of Science Education for Secondary School	Tanzania (1), Uganda (1), Zimbabwe (1), Ghana (1), South Africa (1), Zambia (1): Total (6)	・Consignment: MEXT ・Training institution: Graduate School of Education, Hiroshima University
2003	Country Focused Training Course in Primary Education (Southwest Asian Countries) II	Bangladesh (2), Sri Lanka (2), Pakistan (2), Maldives (2): Total (8)	・Consignment: Northern Regions Center ・Training institution: Obihiro Board of Education
	Practice of Science Education for Secondary School	Tanzania (2), Uganda (1), Ghana (1), South Africa (1), Zambia (1), Malawi (1): Total (7)	・Consignment: MEXT ・Training institution: Graduate School of Education, Hiroshima University
2004	Country Focused Training Course in Primary Education (Southwest Asian Countries) II	Bangladesh (4), Sri Lanka (2), Maldives (1), Nepal (2): Total (9)	・Consignment: Northern Regions Center ・Training institution: Obihiro Board of Education
	Practice of Science Education for Secondary School	Tanzania (1), Ghana (1), South Africa (1), Gambia (2), Kenya (l), Nigeria (1): Total (7)	・Consignment: MEXT ・Training institution: Graduate School of Education, Hiroshima University
2005	Country Focused Training Course in Primary Education (Southwest Asian Countries) II	Bangladesh (2), Sri Lanka (2), Nepal (2), Pakistan (2): Total (8)	・Consignment: Northern Regions Center ・Training institution: Obihiro Board of Education
	Practice of Science Education for Secondary School	Tanzania (1), Ghana (1), Kenya (1), Nigeria (1), Malawi (1), Namibia (1): Total (6)	・Consignment: MEXT ・Training institution: Graduate School of Education, Hiroshima University

Note: JICA plans to launch "the Regional Training Course for the Pacific on Mathematics Education in Primary and Secondary School" in FY2006, and two courses in FY2007: "Improving Teaching Methods in Science and Mathematics in Primary Education," and "Science and Mathematics Education Improvement in Primary Education (Middle Eastern Countries)." Each course will accept about 10 participants each year.

Chart 6: Participants in Third-Country Training in M&S Education (between FY2003 and FY2006)

FY	Course title	Participating country (Number of participants)	Training institution
2003	ASEI[13] & PDSI[14] approach in secondary mathematics and science education	Lesotho (8), Malawi (2), Mozambique (8), Rwanda (6), Uganda (2), Zambia (10), Zimbabwe (6): Total (42)	Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA)
2004	ASEI & PDSI approach in secondary mathematics and science education	Botswana (5), Burundi (8), Malawi (11), Niger (8), Nigeria (6), Rwanda (2), Senegal (3), Swaziland (8), Tanzania (7), Uganda (6), Zimbabwe (2), Ethiopia (4), Madagascar (4), Mauritius (5), Seychelles (6): Total (85)	Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA)
2005	ASEI & PDSI approach in secondary mathematics and science education	Cameroon (5), Nigeria (18), Senegal (5), Sierra Leone (4), Tanzania (2), Uganda (15), Benin (8), Burkina Faso (7), Cote d'Ivoire (5), Ethiopia (3), Gambia (10), Madagascar (4), Seychelles (2), Zanzibar (7): Total (95)	Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA)
2006	ASEI & PDSI approach in secondary mathematics and science education (English-speaking countries)	Botswana (7), Ghana (8), Lesotho (7), Malawi (7), Mozambique (7), Nigeria (6), Sierra Leone (8), Swaziland (8), Tanzania (7), Uganda (8), Zambia (7): Total (80)	Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA)
	ASEI & PDSI approach in secondary mathematics and science education (French-speaking countries)	Burundi (8), Cameroon (5), Niger (23), Rwanda (20), Senegal (22), Burkina Faso (8): Total (86)	Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA)

4. Acceptance of Mathematics and Science Teachers under the Youth Invitation Program

The Youth Invitation Program was launched in 1984 in order to support fostering human resourses in the developing countries. It is designed to invite young people from developing countries to Japan who will play a pivotal role in the development of their countries. During their stay in Japan for 23 days, they receive training aimed at improving their knowledge and skills in their respective areas of expertise. They also participate in a seminar camp where they exchange views with Japanese youths and experience Japanese culture through a home stay and other occasions. A total of 572 science and mathematics teachers from 61 countries participated in this program between 2000 and 2005, along with the other participants (Chart 7).

[13] Activity, Student-centerd, Experiment, Improvised
[14] Plan-Do-See-Improve

Chart 7: Mathematics and Science Teachers (M&S Education) Accepted under the Youth Invitation Program (between FY2000 and FY2005)

FY	Course title	Participating country (Number of participants)	Training institution
2000	Teachers (M&S Education)	Indonesia (23)	–
	Teachers (M&S Education)	Malaysia (25)	–
	Teachers (M&S Education)	Philippines (23)	–
	Teachers (M&S Education)	India (30)	–
	Education (Secondary M&S Education)	Bangladesh (20)	–
	M&S Educations	Botswana (1), Egypt (2), Eritrea (1), Ethiopia (1), Gambia (1), Ghana (2), Kenya (2), Lesotho (1), Malawi (1), Mauritius (1), Mozambique (1), Namibia (1), Nigeria (2), Seychelles (1), South Africa (1), Swaziland (1), Tanzania (2), Uganda (2), Zambia (2), Zimbabwe (1): Total (27)	–
	Teachers (M&S Education)	Angola (1), Benin (1), Burkina Faso (1), Burundi (1), Cameroon (1), Cape Verde (1), Congo (1), Djibouti (1), Gabon (1), Guinea (1), Madagascar (1), Mali (1), Mauritania (1), Morocco (1), Niger (1), Rwanda (1), Sao Tome and Principe (1), Senegal (1), Togo (1), Tunisia (1): Total (20)	–
2001	Teachers (M&S Education)	Sri Lanka (15)	・Japanese Association of the Experiment in International Living ・Federation of World Youth Nagano
	Teachers (M&S Education)	Egypt (1), Ethiopia (1), Gambia (1), Ghana (2), Kenya (3), Lesotho (1), Malawi (1), Namibia (l), Nigeria (3), Seychelles (1), South Africa (1), Uganda (3), Tanzania (2), Zambia (2), Zimbabwe (1): Total (24)	・International Hospitality and Conference Service Association ・Kagoshima International Association
	Teachers (M&S Education)	Burkina Faso (1), Burundi (1), Cameroon (1), Cape Verde (1), Central African Republic (1), Chad (1), Congo (1), Cote d'Ivoire (1), Djibouti (1), Gabon (1), Guinea (1), Guinea-Bissau (1), Madagascar (1), Mali (1), Mauritania (1), Niger (1), Senegal (1), Togo (l): Total (18)	・Junior Executive Council of Japan ・Tsuyama International Friendship Society
2002	Education (M&S Teachers)	Myanmar (20)	・National Assembly for Youth Development ・Japan Overseas Cooperative Association of Kyushu
	M&S Teachers	Egypt (3), Tunisia (1), Botswana (1), Ethiopia (1), Eritrea (2), Ghana (2), Kenya (3), Lesotho (1), Namibia (1), Seychelles (1), South Africa (1), Swaziland (1), Uganda (1), Tanzania (1), Zambia (2): Total (22)	・Junior Executive Council of Japan ・Yamaguchi International Exchange Association
	M&S Teachers	Benin (1), Burkina Faso (1), Burundi (2), Cameroon (1), Cape Verde (1), Central African Republic (1), Chad (1), Republic of Congo (1), Cote d'Ivoire (1), Djibouti (1), Equatorial Guinea (1), Gabon (1), Guinea (1), Guinea-Bissau (1), Madagascar (1), Mali (1), Mauritania (1), Niger (3), Sao Tome and Principe (1), Senegal (1), Togo (1): Total (24)	・Japan Youth Hostels, Inc. ・Takikawa International Exchange Association

FY	Course Title	Participating country (Number of participants)	Training institution
2003	M&S Teachers	Sri Lanka (15)	・Japanese Association of the Experiment in International Living ・Takikawa International Exchange Association
	M&S Teachers	Egypt (4), Morocco (1), Tunisia (2), Ethiopia (1), Eritrea (2), Ghana (2), Kenya (3), Lesotho (1), Malawi (1), Namibia (1), Nigeria (1), Seychelles (1), South Africa (1), Tanzania (2), Zambia (1), Zimbabwe (1): Total (25)	・Kagoshima International Association
	M&S Teachers	Benin (1), Burkina Faso (1), Burundi (1), Cameroon (1), Chad (1), Republic of Congo (1), Cote d'Ivoire (2), Djibouti (1), Equatorial Guinea (1), Gabon (1), Guinea (1), Madagascar (1), Mali (1), Mauritania (1), Mozambique (1)Niger (3), Senegal (3), Togo (1): Total (23)	・Japan Youth Hostels, Inc. ・Tsuyama International Friendship Society
2004	Education (M&S Educations)	Philippines (23)	・Japan Overseas Cooperative Association ・Ishikawa Youth Hostel Association
	Teachers (M&S Education)	Algeria (1), Egypt (2), Morocco (1), Tunisia (1), Botswana (1), Ethiopia (2), Ghana (2), Kenya (1), Malawi (1), Namibia (1), Nigeria (2), Seychelles (1), South Africa (2), Uganda (1), Tanzania (2), Zambia (2), Zimbabwe (1): Total (49)	・Komatsu International Association
	Teachers (M&S Education)	Angola (1), Benin (1), Burkina Faso (1), Burundi (1), Cameroon (1), Chad (1), Republic of Congo (1), Cote d'Ivoire (2), Djibouti (1), Equatorial Guinea (1), Gabon (1), Guinea (1), Madagascar (1), Mali (1), Mauritania (1), Mozambique (1), Niger (2), Sao Tome and Principe (1), Senegal (1), Togo (1): Total (22)	・Japan Youth Hostels, Inc. ・Tsuyama International Friendship Society
2005	Education (Secondary M&S Education)	Sri Lanka (24)	・Japanese Association of the Experiment in International Living ・Japan Overseas Cooperative Association of Kumamoto
	Education (secondary M&S, IT)	Mongolia (15)	・International Good Neighborhood Association ・Osaka Youth-Hostel Ass.
	Education (M&S Education)	Belize (1), Costa Rica (1), Dominican Republic (2), El Salvador (2), Guatemala (2), Honduras (2), Nicaragua (2), Panama (1): Total (13)	・Japanese Association of the Experiment in International Living ・Shobara International Exchange Association
	Education (Secondary M&S Education)	Egypt (2), Morocco (2), Ethiopia (2), Eritrea (1), Ghana (2), Kenya (2), Lesotho (1), Malawi (1), Nigeria (2), Seychelles (1), Swaziland (1), Uganda (1), Tanzania (2), Zambia (1), Zimbabwe (1): Total (22)	・Japan Overseas Cooperative Association ・Japan Overseas Cooperative Association Of Kyushu
	Education (Secondary M&S Education)	Benin (1), Burkina Faso (1), Burundi (1), Cameroon (1), Chad (1), Cote d'Ivoire (2), Djibouti (1), Gabon (1), Guinea (1), Madagascar (1), Mauritania (l), Mozambique (1), Niger (2), Sao Tome and Principe (1), Senegal (1), Togo (1), Republic of Congo (1): Total (19)	・Ageo Global Association ・Japan Overseas Cooperative Association

5. Grant Aid

Grant Aid is a type of financial cooperation in which the recipient countries have no obligation to provide repayment. This program is particularly directed at the least developed countries for supporting them in improving their living standards, with particular emphasis on social and economic infrastructure (infrastructure development), basic human needs (BHNs), the environment, and human resource development. Recent years have seen an increasing number of cases where the program has addressed not only physical aspects such as physical facilities and teaching/learning materials, but also non-physical aspects such as technical guidance and human resource development in cooperation with technical cooperation projects for more efficient assistance.

In the education sector, the number of grant aid projects for constructing primary and secondary schools has increased rapidly since the 1990 World Conference on Education for All. As far as M&S Education is concerned, a total of six grant aid projects have been implemented in coordination with technical cooperation projects for the purpose of constructing a teacher training college or a teacher training center, or procuring laboratory instruments and equipment in such countries as the Philippines, Kenya, and Indonesia (Chart 8).

Chart 8: Examples of Coordination between Grant Aid and Technical Cooperation in M&S Education

FY	Country / Project title	Technical cooperation project in coordination
1987	Honduras Construction of the National Institute for Research and Education Training (INICE) (Facilities/equipment)	・Project for the Improvement of Teaching Method in Mathematics April 2003 - March 2006 April 2006 - March 2011
1988	Philippines Project for the Construction of the National Learning Resources Centre for Teacher Training in Science and Mathematics Education (Facilities/equipment)	・Package Cooperation/ Science and Mathematics Education for Manpower Development Project (SMEMDP) June 1994 - May 1999
1996	Kenya Project for Improvement of Equipment for Kenya Science Teachers College (Equipment)	・Strengthening of Mathematics and Science in Secondary Education Project July 1998 - June 2003 July 2003 - June 2008
1998 ～ 2000	Indonesia Project for Improvement of Science and Mathematics Teaching for Primary and Secondary Education (Facilities/equipment)	・Project for Development of Science and Mathematics Teaching for Primary and Secondary Education October 1998 - September 2005 ・Project for Strengthening In-service Teacher Training of Mathematics and Science Education at Junior Secondary Level May 2006 - October 2008
1999	Papua New Guinea Project for Development of the Facilities for Education Media Programmes (Equipment)	・Project for Enhancing Quality in Teaching through TV Program August 2005 - November 2008
2004	Malawi Project for Improvement of Domasi College of Education (Facilities/equipment)	・Project for Strengthening of Mathematics and Science in Secondary Education through In-Service Training October 2004 - October 2007