11. International Comparative Study on Content and Teaching Methods for Cultivating Creativity in Mathematics Education

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(1) Purpose and Aim of Study

This study follows on from the International Comparative Study on the Cultivation of Creativity and Originality in Mathematics Education in Japan, the United States, Russia and Korea conducted in fiscal 2002, and the International Comparative Study on Policies and Realities in the Cultivation of Creativity in Mathematics Education conducted in fiscal 2003 and 2004. Its aim is to bring together the five years of research on teaching content and methods in programs for cultivating creativity in school mathematics in Japan and other countries, and to present proposals thereon.

The study was premised on the following four basic points:

(1) That "creativity" should be defined holistically as "the capacity to think independently about new problems and to generate new outcomes."
(2) That the researchers should take into account not only the objective of nurturing talented individuals to make scientific discoveries and produce technical achievements ("for excellence"), but also the cultivation of higher-order thinking among all students ("for all").
(3) That field surveys of initiatives in the cultivation of creativity outside Japan should be conducted on an ongoing basis and their characteristics reviewed in light of educational policies in the subject countries.
(4) That matters thought to be of use for educational practice in Japan should be reported at academic conferences and other gatherings, and that discussions should be held widely with educators and ideas solicited.

(2) Outline of Research Results

• Overseas field surveys

In fiscal 2002, we surveyed trends in the U.S., the Russian Federation and Korea, focusing on special schools (classes) for students highly proficient in mathematics. In fiscal 2003 and 2004, we looked at U.S., the Russian Federation and Korea, as well as Singapore, the Netherlands, Finland and other countries that record excellent overall results in international tests of

academic ability such as IEA's TIMSS and the OECD's PISA. The historical backgrounds and distinctive features of mathematics education policy in these countries were examined. In fiscal 2005 and 2006, we supplemented the existing research findings from the perspectives of Asia and the West, and integrated the findings on teaching content and methods. Surveys were conducted in China (Experimental Elementary School attached to Beijing Normal University) for Asia, and in the Netherlands (Freudenthal Institute, Math A-lympiad, Math B-day) for the West.

• Collection and exchange of information on case studies in Japan and other countries

Professor IITAKA Shigeru from Gakushuin University was engaged to give a lecture on special education for gifted students in mathematics in Japan. Opportunities were also furnished for sharing insights with teachers from Super Science High Schools and other organizations engaged in advanced practice and discussing paradigms for mathematics education in Japanese schools. Case studies were also gathered from Finland, Korea, the United States, and other countries.

• Summary of findings from five years of research on the cultivation of creativity

Based on our reviews of the genealogy of education to cultivate creativity, cases of teaching practice and curricula in other countries, and the backgrounds and social impact in policy terms, we made the following proposals concerning a model for the cultivation of creativity.

1. Balance should be maintained between formal training in areas such as problem-solving and logical thinking, and practical training such as the application of mathematics to the real world.
2. Multi-dimensional learning content and instructional methods should be developed in order to ensure that education is fair and responsive to individual abilities and aptitudes.
3. Educational administration, academia, research institutes, private organizations, and foundations should collaborate to develop systems to support the cultivation of creativity, so that a comprehensive system can be built around school education.

4. Where there are special courses, schools, or classes for students who are especially talented in mathematics, consideration should be given to methods for determining the appropriate ages at which to implement them, for evaluating “creativity” and other special talents, and for gauging public reactions to them.