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An Enrichment Program for the Mathematically Gifted Students in First Grade[1]

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We developed an enrichment program material for the mathematically gifted students in the first grade. The contents were selected and organized based on creative competency improving, increasing of interest, inquiry various activity, interdisciplinary approaches, and the enrichment contents from modern mathematics.

Keywords: mathematically gifted student, interdisciplinary approach, enrichment contents
ZDM Classification: C70
MSC2000 Classification: 97C90

I. INTRODUCTION

Talented mathematicians and scientists are of great value and benefit to society. The development of talented individuals is a long and difficult process that obviously should start in elementary school. This is one of the major goals of the educational system in Korea.

Since 1999, the starting year of Korean 'Gifted Education Act', some of programs and materials for the mathematically gifted students are proposed. The gifted education should be composed of various educational content and method by considering the characteristics of the gifted. Under the 'Gifted Education Act', special purposed high

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schools for the gifted and talented, after-school enrichment programs in elementary and junior high schools, acceleration, enrichment programs provided by gifted education centers affiliated with school boards or universities were established, and the newly proposed cyber gifted education systems.

In 1999, the Korean Education Research Institute (KEDI) developed general curriculum for the gifted and talented (Cho, H. Kim, S. Kim, Bang & Hwang 2000; Gu, Cho, H. Kim, Seo, Jang, Hwang & Lim 1999). After the development of general curriculum for the gifted and talented, some of studies on mathematically gifted and talented were performed. That is, development of the curriculum for the mathematically gifted and talented (Gu, Cho, H. Kim, Seo, Jang, Lim, Bang & Hwang 2000; Hwang, Hong & Seo 2002), after-school enrichment programs in elementary and junior high schools (Han 2000, 2001; Bang, S. Lee & W. Lee 2002; Korean Educational Development Institute (KEDI) (2002, 2003) were concerned.

However, the mostly programs were for the gifted in middle school. We have only material for the first grade regular classroom developed by the KEDI. It has been necessary that providing enrichment programs for the first grade mathematically gifted students.

The purpose of this study is carried out to develop an enrichment program for the mathematically gifted students in the first grade who are identified by and participate in the enrichment programs provided by the gifted education centers affiliated with school boards or universities in Korea.

II. ORGANIZATION AND DEVELOPMENT OF TEACHING MATERIALS

1. Research Trends on Enrichment Programs for Mathematically Gifted

Gu, Cho, H. Kim, Seo, Jang, Lim, Bang & Hwang (2000) and Hwang, Hong & Seo (2002) have picked out some points concerning the methods of teaching and learning for the mathematical gifted out of the basic trend of program development in education for the mathematical gifted as we researched on how to maximize the mathematical gifted considering their properties based on the general analysis of the education program for the talented high school students in domestic as well as in abroad.

KEDI (2002, 2003), Kim (2001) and Han (2001) have suggested teaching-learning materials as well as a direction on development of the teaching-learning material for the gifted students. To present some of them, there are creative problem solving ability in concerned subject, developing high-order thinking power, interest in the concerned subject content & activity, concentration on assignment, developing self-confidence, developing self-directed learning attitude, focusing more on reinforcing than speed

renovating study, individualized education, diverse degree of difficulty & presenting reinforcing activity assignment, including content from various area, connecting with problem situation which can occur in actual life, composing of sub-subject, interdisciplinary subject, including content or activity, organizing various group, various teaching-learning material, application on location, emphasizing on creative products.

Any program for mathematically talented students should be expected to measure up on the following essential components (*cf.* NCTM 1987): First, the mathematical content of the program must be of a high quality. These differences should be reflected in the difficulty, cognitive level, breadth, and depth of the curriculum. Second, programs for the mathematically gifted and talented must nurture high-level thinking processes. Third, efforts must be made to include applications of mathematics to real-world situations as well as the examination of standard topics in greater depth. Fourth, the ability to communicate is essential in learning mathematics. Fifth, mathematics, with its unique content characteristics, provides an effective vehicle for developing study skills and work habits. Eight, the program must provide opportunities for students to explore mathematical ideas in a creative fashion. Ninth, Gifted students need frequent and imaginative use of manipulative materials and other instructional aids. Mathematics should be related to other content areas of school program.

As we plan programs for these top students, we first examine the purposes behind our programs. There are many reasons that we might want to help students develop their mathematical abilities (*cf.* Sheffield 1999). These include: First, Helping students become deep mathematical thinkers. Second, developing an informed citizenry. Third, Allowing students to experience the joy and the beauty of mathematics. Forth, enabling students to be competitive at the university level and beyond. Fifth, developing world leaders in our increasingly technological world.

All leaders of mathematics interest circles are offered syllabus prepared by specialists from the ministry of education and Science or they are allowed to develop programs independently (*cf.* Velikova 1999). The goals of such interest circles are to

(1) expand and deepen students' knowledge,
(2) develop students' skills and habits,
(3) cultivate students' interest in various fields of mathematics,
(4) have students acquire skills for appropriate use of reference or scientific literature,
(5) have students develop the language and style of mathematics that will enable them to write short reports about the life and work of prominent mathematicians or new scientific discoveries, and
(6) prepare materials for bulletin boards and newspapers.

2. Enrichment Program for the mathematic ally gifted

In the recently study have developing enrichment program to classify problem-centered programs and research-centered programs. Bang (1998) suggested that step by step enrichment program and Nam (2000) suggested that problem solving enrichment program, topic research enrichment program and a subject solving enrichment program. Song (2004) suggested that three-stage mathematical creativity enrichment model. Mathematical creativity does not occur in a vacuum; (1) Stage 0: A preliminary technical stage; (2) Stage 1 : Algorithmic activity; Stage 2 : The creative (conceptual, constructive) activity. Velikova (2004) suggested that a new Model of Joint and Independent Creative Work (MJICW). The model (MJICW) is principally based on the Schoolwide Enrichment Model of J. Renzulli and S. Reis but also includes original authors methods (a system of mathematical problems that includes geometrical inequalities, a system of transformations, mathematical methods for creating new transformations and new problems, teaching methods, research methods) and also authors experience; (1) Activities of Type I (general preparation, general exploratory activities); (2) Activities Type II (preparation for creative work, group training activities); (3) Activities of Type III (creative work) (*cf.* Velikova, 2004).

3. Three-Stage Mathematical Creativity Enrichment Model

1) Activity Process and Corresponding Emphases in the Mathematical Creativity Program

See Lee, Hwang & Lee (2004)

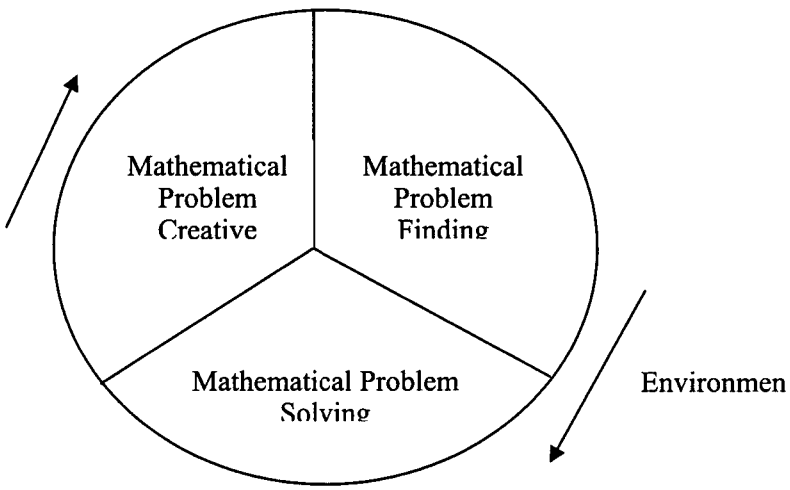

Figure 1. Organizational Mathematics Creativity as a Process

Table 1. Three-Stage Mathematical Creativity Enrichment Model for mathematically gifted and regular students

Learning Activity	Creativity Type	Teaching Method
* perform topic-center project * inquiry into solving in real problem * problem solving and application method * creative productivity	**Type III: Mathematical problem creative activity** * providing opportunities for applying interest, knowledge, creative thinking * providing opportunities for learning thinking ability * providing opportunities for developing self-directed learning skills * providing opportunities for developing what-if and what-if not strategies * providing opportunities for developing self-confidence skills * providing opportunities for developing originality productivity	* problem based teaching method * self-evaluation and peer-evaluation teaching method * presentation and discuss teaching method
* developing creative thinking and problem solving * developing affective processes experience * developing various communication unction	**Type II : Mathematical problem solving activity** * providing opportunities for learning creative thinking and problem solving * providing opportunities for learning experimentation and research method * providing opportunities for learning creative thinking * providing opportunities for learning communication ability	* activity center teaching method * experimentation-inquiry-discovery learning method * presentation study * developing creative thinking ability skills
* inquiry into self-interest areas * connecting with problem situation which can occur in real situation * inquiry into a wide variety literature activity	**Type I : Mathematical problem finding activity** * providing opportunities for learning topic and basic knowledge * a guide to curiosity of knowledge and interesting * a decision to direction for the Mathematical problem solving activity	* basic knowledge in concerned subject learning * developing creative thinking ability skills

We suggested that three-stage mathematical creativity enrichment model;

(1) First Stage: mathematical problem finding;
(2) Second Stage: mathematical problem solving;
(3) Third Stage: mathematical creative.

Table 2. Enrichment program for the mathematically gifted

Contents No.	Numbers and	Figures	Measures	Patterns and Functions	Symbols and Formula
1	Making to numbers and formula	The art of figures	Finding to length	Finding to mathematical fact using the flag	Joy of game one
2	Finding to quantity	The art of Circle	The world of the measures using quadrangle	Design of the patterns	Joy of game two
3	Finding to numbers	Tangram and Mosaic Puzzle derivative called Trigo-Tangram	Finding to mathematical fact using the forest	Mathematics using plays	Making to Maze
4	Invest to fractional numbers using umbers cake	Tessellation to connect geometry with pattern	Making to castles using the block	Making to patterns	The world of reasoning
5		Joy of puzzles			
Total	52 times				

Mathematical problem finding means continuously and deliberately discovering and useful problems to be solved. Mathematical problem solving means developing new, useful, imaginative solutions to these problems. Mathematical creative means continuously and deliberately formulating new and conceptual new and constructive new activity.

Activity process and corresponding emphases in the mathematical creativity program:

1. Problem Finding: Topics/basic knowledge across domains of learning
2. Problem Solving: Concepts/themes/ideas across domains of learning (Process/product depth considerations)
3. Problem Creation: Advanced Content/Creative productivity

2) Three-Stage Mathematical Creativity Enrichment Model for mathematically gifted and regular students

See Lee, Hwang & Lee (2004) and Table 1 on page 207.

III. PRACTICE OF DEVELOPING ON ENRICHMENT PROGRAM

1. Content of the learning materials

See Table 2 on page 208.

2. Practice of developing learning materials

1) Guide to the activity

Content: Patterns and Functions
Topics: Finding to mathematical fact using the flag
The form of activity: small group
Goals: The classify is the same patterns using the flag. How many different ways of coloring the flag red, yellow and blue are there if adjoining regions must be of different colors? The final activity is creative making to the coloring flags and Badges.

Table 3. Guide to the activity

Stages	Activity as a process	teaching-learning activity	
		teaching activity	learning activity
Proposal of the situations (2 min)	(1) Warming-up	▶ We showed that flags and coloring badges in the around ▶ Find to the flag	▶ Find to the flag
	(2) Presentation of the situations and problem posing	The classify is the same patterns using the flag. The final activity is creative making to the coloring flags and Badges.	

Applications	(3) Small group activity	* Activity 1. The classify is the same patterns using the flag ▶ The classify is the same patterns using the flag * Activity 2. Making to flag using colors ▶ How many different ways of coloring the flag using two colors ▶ How many different ways of coloring the flag red, yellow and blue are there if adjoining regions must be of different colors?	▶ The classify is the same patterns using the flag ▶ How many different ways of coloring the flag using two colors ▶ How many different ways of coloring the flag red, yellow and blue are there if adjoining regions must be of different colors?
Evaluations		▶ How many different ways of coloring the flag red, white and blue are there if adjoining regions must be of different colors? * Activity three. Coloring Badges ▶ The badge is to be colors red, green and blue. How many different badges could be colored in? * Activity 4. Making to the coloring flags and Badges	▶ How many different ways of coloring the flag red, white and blue are there if adjoining regions must be of different colors? ▶ How many different ways of coloring the badges red, white and blue are there if adjoining regions must be of different colors?
	(4) Evaluations	▶ Presentation of the coloring Flags and Badges	▶ Presentation of the coloring Flags and Badges

IV. RESULTS AND CONCLUSION

In this study, 21 programs have been developed for the gifted students in the mathematics. The basic guidelines for development of the programs are as follows.

First, raising creative problem solving ability is stressed very much in the programs. To raise creative problem solving ability, the programs were made to induce interests and problem finding for students.

Second, the programs are planned to carry out by self-directed learning. To raise self-directed learning, every activity was constructed to do by themselves minimizing the help of teachers.

Third, programs were developed to raise interests, concern and creative for students. The topics deeply related to real life situations were also selected.

The developed programs will be used in the regular classrooms and after-school enrichment programs in elementary. Also they will be good programs for the club activity and special enrichment programs for the gifted and talented students.

In this study, we developed on enrichment programs materials in elementary first grade for the mathematically gifted and base on increase creative competency contain on the increase interest, However we have no almost identifying the mathematically gifted elementary school students and providing enrichment programs and the government has the responsibility to support the gifted education financially and administratively. Second, it is necessary to set up a national policy and expand it to produce gifted students from providing enrichment programs.

REFERENCES

Bamberger, H. J. (1998): Using a "Standards-Based" Approach to Teaching Mathematics. *Business Monthly* **1998 (January)**.

Bang, S. (1998): *A study of identification for mathematics gifted.* Suwon, Korea: Institute for Gifted Education, Ajou University.

Bang, S.; Hong, J. & Hwang, D. (2001): Development of Curriculum for the Gifted in the High Schools. *Journal of the Korea Society of Mathematical Education Series F: Studies in Mathematical Education* **6**, 223–245.

Bang, S.; Lee, S.; & Lee, W. (2002): Development of Enrichment Programs for the Mathematically Gifted: Focused on the 9th grade, *Journal of the Korea Society of Mathematical Education Series F: Studies in Mathematical Education* **7**, 103–119.

Cho, S.; Kim, H.; Kim, S.; Bang, S. & Hwang, D. (2000): *Development of Curriculum for the Scientifically Gifted.* Seoul: Korean Education Development Institute, 2000.

Gu, J.; Cho, S.; Kim, H.; Soe, H.; Jang, Y.; Hwang, D. & Lim, H. (1999): *Development of Curriculum for the Gifted-Fundamental Study of development the curriculum for the gifted in elementary and the middle schools.* CR 99-20. Seoul: Korean Education Development Institute.

Gu, J.; Cho, S.; Kim, H.; Soe, H.; Jang, Y.; Lim, H.; Bang, S. & Hwang, D. (2000): *Development of Curriculum for the Gifted-Fundamental Study of development the curriculum for the gifted in the high schools.* Seoul: Korean Education Development Institute, 2000.

Han, I. (2000): A study of development the Enrichment Program Materials: Focused on a problem for construction, *Journal of the Korea Society of Mathematical Education Series F: Studies in Mathematical Education* **5**, 221–232.

Han, I. (2001): The direction for development the program in middle and the high schools for the mathematical gifted. In: *Proceedings of the Korean Society for the Gifted.*

House, P. (Ed.) (1987): *Providing Opportunities for the Mathematically Gifted*, K-12. Reston, VA: National Council of Teachers of Mathematics.

Hwang, D.; Hong, J. & Seo, J. (2002): An Analytic Study of Mathematics Gifted/Talented Education Program of U.S.A. by ERIC Search, *Journal of the Korea Society of Mathematical Education Series F: Studies in Mathematical Education* **7**, 121–131.

Korean Educational Development Institute (KEDI) (2002): *Development of Instructional Materials for the Gifted Students in the Regular Schools.* Seoul: Korean Education Development Institute.

_____ (2003): *Development of Instructional Materials for the Gifted Students in the Regular Schools.* Seoul: Korean Education Development Institute.

Kim, S. (2001): *The direction for development the program in elementary schools for the mathematical gifted.* Proceeding of the Korean Society for the Gifted.

Lee, K.; Hwang, D., &. Lee, W. (2004): *Development of Enrichment Programs for the Mathematically Gifted: Focused on the Conic section* (pp. 125–132). Proceedings of the ICMI-10.

Lee, S., & Han, I. (2000): A study of development the Geometrical Enrichment Program Materials: Focused on a analogy. *Journal of the Korea Society of Mathematical Education Series F: Studies in Mathematical Education* **5**, 165–174.

Nam, S. (2000): Direction of the teaching for gifted students in elementary. Journal of the Korea Society of Mathematical Education Series F: Studies in Mathematical Education **5**, 21–37.

NCTM (1987): *Providing Opportunities for the Mathematically Gifted*, K-12. Edited by House, Reston, Virginia: NCTM.

Sheffield, R. (1999): Serving the needs of the mathematically promising. In: L. J. Sheffield (Ed.), *Developing mathematically promising students* (pp. 43–55). Reston, VA: National Council of Teachers of Mathematics.

Shin, H.; Lu, G., & Han, I. (2000): A study on the Gifted Education for the Mathematical Special Class in the Special High Schools, *Journal of the Korea Society of Mathematical Education Series F:: Studies in Mathematical Education* **5**, 125–140.

Song, S. (2004): *Creativity in Mathematics Education* (pp. 167–171). A paper presented at the 8th Asia-pacific Conference on Giftedness. July 26–30, 2004. Daejeon, Korea.

Velikova, E. (1999): One Bbulgarian experience in identifying and developing mathematically talented students. In: L. J. Sheffield (Ed.), *Developing mathematically promising students* (pp. 203–206). Reston, VA: National Council of Teachers of Mathematics.

Velikova, E. (2004): *Extracurricular work with creative-productive gifted students-program and activities* (pp. 71–82). Proceedings of the ICMI-10.

Zhang, D. & Lee, P. Y. (1990): Examination culture and mathematics teaching. In: *Proceedings of ICMI-China Regional Conference* (pp. 40–46). Beijing.

Zhang, D. (2002): Textual research in Qing Dynasty and mathematics education. *Science* **54(2)**, 43–47.