A Study on Developing the Teacher Education Program for Mathematical Excellence

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To develop the content and form of the teacher education program for mathematical excellence, we reviewed several teacher education programs. CGI is an excellent model for teacher education program for mathematical excellence. We developed the 12 teacher education programs based on mathematical tasks developed for the gifted children and have applied them to teacher education. It is not so difficult to develop more programs, because we have made a lot of tasks for the gifted in mathematics for 8 years. Wooden Die for Drinking Game which is one of 12 programs is introduced in this article.

Keywords: Teacher education, Wooden Die for Drinking Game.
ZDM classification: B52, B53, U62, U63
MSC2000 classification: 97B50, 97C80

I. INTRODUCTION

The Korea Science Foundation and Ministry of Science and Technology have helped to establish the Centers for Science Gifted Education in 15 universities since 1998 (see Shin & Han 2000, pp. 81–84 for details). Also, the Ministry of Education has established a special school, and classes for gifted children since March 2002, as described in the Gifted and Talented Education Act of 2000. Such fundamental and systematic support at the national level can be helpful in realizing a desirable education system for a gifted students, but what is more important for its success is to emphasize teacher education. To improve education opportunities for America’s top students, they suggested such steps as setting challenging curriculum standards, providing more challenging opportunities to learn, increasing access to early childhood education, increasing learning opportunities for disadvantaged and minority children with outstanding talents, broadening the

We have made an effort to realize a gifted education in mathematics, science, and information technology. The Center for Science Gifted Education (CSGE) of Chongju National University of Education was established in 1998 with the financial support of the National Science Foundation and Ministry of Science and Technology of Korea. Now we have made a lot of talented education programs which in-service teachers could apply to mathematics classroom for mathematical excellence.

The content of this study is as follows: Firstly, to develop the content and form of the teacher education program for mathematical excellence on the basis of reviewing several teacher education programs. Secondly, to develop the teacher education programs based on mathematical tasks developed for the gifted children and to apply them to teacher education.

II. CGI AS A TEACHER EDUCATION PROGRAM

The Cognitively Guided Instruction (CGI) research program at the University of Wisconsin has shown that providing teachers with knowledge of how students think and develop strategies in specific content domains influences their teaching practices and, in turn, student learning. Students in CGI classes demonstrated increased learning, particularly in problem solving, when compared to students in control classes. There were no performance differences between two groups on computational tasks (Carpenter, Fennema, Peterson, Ching & Loef 1989).

The success of the CGI model in enhancing the professional development of practicing teachers led to investigations of using the CGI concepts and methods in the preparation of pre-service teachers. Furthermore, they had 2nd Biennial CGI National Conference in which consisted of such following two tracks as track A and B at St. Paul, MN during October 25–26, 2002. Most of participants were teachers who were interested in CGI or had practiced CGI in the classroom. The experiences of CGI teachers could be a best program for teacher education.

1. Program for track A

   (1) Cognitively Guided Instruction in Context: Observing Children & Understanding a Developmental Framework — In this session participants explored the CGI problem types, strategies that students used to solve these problems, the relationship between the problem types and strategies, and how that information could be used to inform and shape instruction. Videotapes of students solving
problems and CGI classrooms were examined.

2. Program for track B

(1) Conjecture & Proof — Presenters shared classroom applications for generating, writing, and justifying conjectures at the elementary level.

(2) Opening the Door to Algebra: Understanding that the equals sign represents a relation between numbers is essential to students’ understanding of arithmetic and
algebra. This session allowed participants to explore specific tasks that developed students’ understanding of equality.

(3) Differentiation in Early Algebraic Thinking — Multiage teachers Carla Nordness and Shannon Richards presented ideas and suggestions for meeting the needs of all learners in a 2nd/3rd graders classroom.

(4) Distributive & Associative Properties — This session focused on the distributive and associative property and how they underlay most of our computational methods and algebra procedures. The session was based on the next to last chapter in “Thinking Mathematically (Carpenter, Franke & Levi 2003).

(5) Children’s Development of Base Ten Understanding — This session explored how children began to build their tens and ones understanding while working with multidigit numbers. The session looked at specific multidigit addition and subtraction strategies children developed.

(6) Children’s Multidigit Multiplication & Division Strategies — Professor Baek in Arizona State University presented her research on children’s strategies for multidigit multiplication & division. She shared different types of strategies, underlying concepts and skills, it’s relationship with place value, and a hypothetical developmental map.

(7) Classroom Action Research Project (CARP) — Teachers from Madison, WI and Phonix, AZ joined together for collaborative research on early algebraic thinking. Over a two-year period these teachers identified questions that would deepen their own understanding of the content and further understand their students’ thinking.

(8) Teachers Teaching Teachers — After working with those teachers for many years, they proposed a staff development project in which they would instruct teachers in a rural school near there on CGI. Warfield and Lubinski conducted sessions with the experienced teachers as they planned and they collected data on their decision-making processes. They shared their findings and called it “Teachers Teaching Teachers”.

### Table 1. Types and Levels of Mathematical Tasks Developed

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<thead>
<tr>
<th>Task Type</th>
<th>Level</th>
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<tr>
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<td>Grade 5 and under</td>
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<td><strong>Experimental tasks (15)</strong></td>
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<td>Calculating Several Numbers by Calculator</td>
<td>Tower of Hanoi</td>
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<td>Top of the Mountain in the Map</td>
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<td>Circle Mystery</td>
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<td><strong>Group Discussion task (15)</strong></td>
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<td>Gulliver’s Travels Geoboard Tic-Tac-Toe and Mathematics</td>
<td>The Classification of Graphs</td>
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<td>Discussion in Mathematics</td>
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<td>Making the Best Basketball Team</td>
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<td><strong>Open-Ended Problem Solving Task (32)</strong></td>
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<td>Logo Programming (1), (2), (3) Tangrams The World of 2,2,2</td>
<td>Pascal’s Triangle Toothpick Puzzle</td>
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<td>Circular Tangrams Making Cubes and Polydrons Understanding 3-Dimension</td>
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<td>Mathematical Puzzles Problem Solving on Some Topics</td>
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<td><strong>Exposition Task (7)</strong></td>
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<td>The Foundation of Logo Programming</td>
<td>A Maze Problem</td>
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III. MATHEMATICS GIFTED EDUCATION PROGRAM IN CNUE

REFERENCES

We have a number of programs for Super Saturday, Summer School, Winter School, and Mathematics and Science Gifted Camp in Chongju National University of Education. Each program is suitable for 90 or 180 minutes of class time. The types of tasks developed can be divided into experimental, group discussion, open-ended problem solving, and exposition and problem solving tasks (Kim 2001). A lot of programs for talented education could be transformed to the programs for teacher education for mathematical excellence.

Levels of the tasks developed for talented elementary students in mathematics can be further divided into grade 5 and under, grade 6, and grade 7 and over (see Table 1).

IV. WOODEN DIE FOR DRINKING GAME (ঁঁঁঁঁঁঁ) AS A TEACHER EDUCATION PROGRAM DEVELOPED IN CNUE

The fundamental rules of creating a teacher education program for mathematical excellence are as follows.

Firstly, create a formal system of program, which consists of Learning Purposes, Preparation Activities, Exploration Activities, Enrichment Activities. Secondly, present an open-ended problem situation which motivates active exploration and problem solving on the basis of students’ own creative ideas, and specific students’ responses, if possible. Thirdly, develop some programs which require using technology such as calculators and computers and their manual for use. Fourthly, develop tasks that cover the contents of the mathematics curriculum impartially, which consists of numbers and operations, geometry, measurement, probability and statistics, letters and expressions, patterns and functions (problem solving).

1. Learning Purpose

It was made of wooden tetradeca-hedron and was unearthed at Anapzi, the site of a pond in the royal gardens in the era of Unified Silla around 674 AD. Archaeologists suggested that it was used for making a promise of a method of drinking rice wine and giving a zest to a banquet when a lot of people came together for a ceremonial feast.

Learning Purpose is to explore a lot of mathematical concepts and principles in relation to this wooden die for drinking game.
Table 2. Teacher Education Program Developed in CNUE

1. Gulliver’s Travels
2. Pascal’s Triangle
3. Wooden Die for Drinking Game
4. Data Processing by Calculator
5. Mathematics in Soma Cube
6. Finding the fastest way to go from A to B
7. Mathematics in Football
8. Mathematics in Geoboard
9. Exploring the Figures in Paper Work
10. Finding the Pythagorean Theorem using Various Square
11. Finding the Pythagorean Theorem using Various Square
12. Problem Solving using Same Area Transformation

2. Preparation Activity

1) Draw a lot of development figures of following regular polyhedrons, if possible.
2) What is the reason for existing just five regular polyhedron?

3. Exploration Activity

1) Roll the dice and play the following game.

![Figure 1. Wooden Die for Drinking Game](image)

Figure 1. Wooden Die for Drinking Game (Ko 1996)

- 🄵️: dance silently
- 🄷️: stay motionless regardless of persons’ rushing upon oneself
- 🄶️: give a loud laugh after drinking
- 🄹️: hit on the nose
- 🄸️: sing and drink for oneself
- 🄷️: drink three cups of wine at once
- 🄵️: drink in one gulp with bending one’s forearm
- 🄷️: stay motionless regardless of people’ tickling your face
- 🄶️: have someone sing a song
- 🄷️: sing a tune for 12 months
- 🄶️: sing a special song for oneself
- 🄲️: compose a poem
- 🄴️: throw out one’s cups if you have two cups of wine
- 🄻️: do not throw away an ugly object

2) It has 6 facets of 2.5cm × 2.5cm regular squares and 8 facets of 2.5cm × 0.8cm hexagons. It is geometrically harmonized with a height of 4.8cm. Calculate the areas of 14 surfaces, and make an experiment on the probability of 14 surfaces.
A student found that the area of square (6.25cm²) was almost same as the area of hexagon (6.45cm²). 18 students integrated their experimental data and found that the probability of 14 faces was the same as 1/14. For example, \( P(1)=0.100961538 \), \( P(2)=0.105082417 \). It was the same as Park & Lee’s (1987) argument that 14 surfaces have the same probability.

3. Enrichment Activity

Make the Wooden Die for Drinking Game using the following development figure. It is an excellent idea to cut 8 vertices from a cube not to be pointed, and make a tetradecahedron. It can be made from an octahedron to cut six vertices as well.
본제위천

1975-1976년, "막바시(막바시)" 일정 당시 몇 안에서 음료한 것으로,
동일신라시대의 귀족들이 이곳을 숙화시(숙화)에서 즐거웠던 나호는 글자와 내용만이 둘러싸인 것으로 추정되는 늙어진 글씨이다.
V. CONCLUSION

To develop the content and form of the teacher education program for mathematical excellence, we reviewed several teacher education programs. We found several projects and studies that addressed mathematics teacher education. Such projects and programs as Cognitively Guided Instruction (CGI), Problem-Centered Mathematics Project (PCMP), The Atlanta Mathe Project (AMP), Elementary Mathematics Project (EMP), Teacher Education and Learning to Teach Study (TELTS), Quantitative Understanding: Amplifying Student Achievement and Reasoning (QUASAR) Project, SummerMath for Teachers Program (SMT), and Teachers Improving Mathematics Education (TIME) are considered representative of those available (Grouws & Schultz 1996). CGI was an excellent model for teacher education program for mathematical excellence, because CGI teachers have exchanged their own experiences and taught teachers in National Conference every year since 2002.

We developed the 12 teacher education programs based on mathematical tasks developed for the gifted children and have applied them to teacher education. The specific written protocols of talented children could be a good material for teacher education for mathematical excellence.

It is not so difficult to develop more programs, because we have made a lot of tasks for the gifted in mathematics for 8 years. The types of tasks developed can be divided into experimental, group discussion, open-ended problem solving, and exposition and problem solving tasks. Levels of the tasks developed for talented elementary students in mathematics can be further divided into grade 5 and under, grade 6, and grade 7 and over.

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