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A Case Study on Evaluating the Teaching of Mathematics in Korea

Kim, Soo-Hwan
Department of Mathematics Education, Chongju National University of Education,
135 Sugok-dong, Heungdeok-gu, Cheongju, Chungbuk 361-712, Korea;
Email: soohwan@cje.ac.kr

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This study was executed in M elementary school for a week, T elementary school for a week, N high school for a week, and S high school for a week in 2000. There were mathematics teacher interviews, mathematics classroom observations, and student interviews in each school. We can draw the conclusion from this study as follows.
Firstly, the teaching of mathematics in both elementary and high school was very good in the standard of mathematical concepts, procedures, and connection.
Secondly, it is very good in the standard of mathematics as problem solving, reasoning, and communication.
Thirdly, it is not so good in the standard of promoting mathematical disposition.
Fourthly, it is good in elementary schools, but not in high schools regarding the standard of assessing students' understanding of mathematics.
Fifthly, it is very good in elementary schools, but not so good in high schools regarding the standard of learning environments.

I. INTRODUCTION

The standards for evaluating the teaching of mathematics are based on the following four assumptions (NCTM 1991). Firstly, the goal of evaluating the teaching of mathematics is to improve teaching and enhance professional growth. Secondly, all teachers can improve their teaching of mathematics. Thirdly, what teachers learn from the evaluating process is related to how the evaluation is conducted. Fourthly, because teaching is complex, the evaluation of teaching is complex. Simplistic evaluation processes will not help teachers realize the vision of teaching mathematics described in these standards.

Such factors in the process of evaluation as the evaluation cycle, teachers as participants in evaluation, and the sources of information are excluded; and the five

factors in Table 1 were used in this study for evaluating the teaching of mathematics.

This study was executed in M elementary school for a week, T for a week, N high school for a week, and S for a week in 2000 (KEDI 2000c). There were mathematics teacher interviews, mathematics classroom observations, and student interviews in each school.

Table 1. The standards for evaluating the teaching of mathematics

1. Mathematical Concepts, Procedures, and Connection
2. Mathematics as Problem Solving, Reasoning, and Communication
3. Promoting Mathematical Disposition
4. Assessing Student's Understanding of Mathematics
5. Learning Environments

II. MATHEMATICAL CONCEPTS, PROCEDURES, AND CONNECTIONS

The evaluation items for Standard 1 are in Table 2.

Table 2. <Standard 1> Mathematical Concepts, Procedures, and Connections

1.1	Demonstrating a sound knowledge of mathematical concepts and procedures
1.2	Representing mathematics as a network of interconnected concepts and procedures
1.3	Emphasizing connections between mathematics and other disciplines and connections to daily living
1.4	Engaging students in tasks that promote the understanding of mathematical concepts, procedures and connections
1.5	Engaging students in mathematical discourse that extends their understand of mathematical concepts, procedures and connections

1. Math Classroom Observation in T elementary school

Topics: *Connection between Bowling Game and Addition.* Level: Grade 1-B

36 Students are divided into 6 groups play the bowling game in the classroom, and make such addition expressions as in Table 3 according to the result of the game. They connect the activity of the bowling game to the concept of addition expressions.

Table 3. Bowling Game and Addition

Number	Bowling Pin Down	Bowling Pin Up	Addition Expression
1	2	8	2+8=10
2	0	10	0+10=10
3	8	2	8+2=10
4	7	3	7+3=10
5	6	4	6+4=10

2. Math Classroom Observation in N high school

Topics: *Connection between Geometric Sequence and Animation.* Level: Grade 11

To produce a vanishing effect in an animation film, the character's image is reduced 50% with each consecutive cell. Suppose the original area of a character's image is defined as 10 cm^2 and the vanishing effect is applied over 8 cells of film. What happens to the area of the character with each successive reduction?

Figure 1. The geometric sequence in an animation file

III. MATHEMATICS AS PROBLEM SOLVING, REASONING, AND COMMUNICATION

The evaluation items for Standard 2 are in Table 4.

Table 4. <Standard 2> Math. as Problem Solving, Reasoning, and Communication

2.1	Modeling and emphasizing aspects of problem solving, including formulating and posing problems, solving problems using different strategies, verifying and interpreting results, and generalizing solutions
2.2	Demonstrating and emphasizing the role of mathematical reasoning
2.3	Modeling and emphasizing mathematical communication using written, oral, and visual forms
2.4	Engaging students in tasks that involve problem solving, reasoning, and communication
2.5	Engaging students in mathematical discourse that extends their understanding of problem solving and their capacity to reason and communicate mathematically

1. Math Classroom Observation in T elementary school

Topics: *Communication on the Shape of Plain Figures.* Level: Grade 1-B

Teacher: "It has four pointed corners. What is it?"

Student: "A quadrilateral".
Teacher: "It has three definite straight lines. What is it?".
Student: "A triangle".
Teacher: "What is the shape of the diskettes which are used in computers?".
Student: "A square".

2. Math Classroom Observation in N high school

Topics: *Problem Solving in an Arithmetic Sequence.* Level: Grade 11

A toilet roll has a circular cylinder with radius 4cm, and 100 rolls that are each 0.1cm thick. What is the difference of the length between the first and 100^{th} roll?

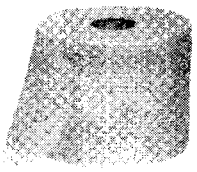


Figure 2. The arithmetic sequence in a toilet roll

IV. PROMOTING MATHEMATICAL DISPOSITION

The evaluation items for Standard 3 are in Table 5.

Table 5. <Standard 3> Promoting Mathematical Disposition

3.1	Modeling the disposition to do mathematics
3.2	Demonstrating the value of mathematics as a way of thinking and its application in other disciplines and in society
3.3	Promoting students' confidence, flexibility, perseverance, curiosity, and inventiveness in doing mathematics through the use of appropriate tasks and by engaging students in mathematical discourse

1. Student interview in M elementary school

Topics: *Engaging Students in Mathematical Discourse.* Level: Grade 1-B

Researcher: "What is the most interesting thing about mathematics?"
Student 1: "Comparing two numbers, order, and the inequality sign".
Student 2: "Counting by fives, tens, and ones".
Student 3: "Bingo game".

Student 4: "Why did you come here and what is your job?"
Student 3: "Where do you live and how old are you?"
Student 2: "Now let's study, sir."
Researcher: "O. K." "There are 59 cows and 92 goats in a boat. What is the age of the captain? (Zhang, Leung, Wong 1998)"
Student 3: "It is 30, because he shouldn't be too fatty and there are a lot of animals ".
Student 1: "It is 151. I can add two-digit numerals, because I have studied a mathematics textbook for 2nd graders".
Researcher: Is the age of the captain related to the number of animals?"
Students: "No."

Students' confidence, flexibility, perseverance, curiosity, and inventiveness in doing mathematics need to be promoted through the use of appropriate tasks and by engaging students in mathematical discourse like this.

2. Student interview in N high school

Topics: *The Value of Mathematics.* Level: Grade 11

Most students in high school are interested in the *College Scholastic Ability Test* (CSAT). CSAT is an advanced test of intellectual thinking ability with regard to integrated subjects of the school curriculum (KICE 2000a). It has 5 sections: Verbal (Korean Language); Mathematics & Inquiry (I); Mathematics & Inquiry (II) (Natural Science & Social Studies Inquiry); Foreign Language (English); Elective Subjects in Second Foreign Languages are adopted in 2001.

Mathematics & Inquiry (I) Section assesses the applicant's level of ability to solve problems by using mathematical concepts and principles. It assesses mathematical thinking ability rather than mathematical knowledge. To make a detailed report, it evaluates computation ability, verbalization/comprehension ability, and reasoning and problem-solving ability (KICE 2000a).

But the *College Entrance Examination System* has been changed too often. So students are in serious anxiety, whenever the system is changed. A student said, "To use a metaphor, we are guinea pigs". Another major problem in CSAT is a failure in the degree of the difficulty in the test.

V. ASSESSING STUDENTS' UNDERSTANDING OF MATHEMATICS

The evaluation items for Standard 4 are in Table 6.

Table 6. <Standard 4> Assessing Students' Understanding of Mathematics

4.1	Using a variety of assessment methods to determine students' understanding of mathematics
4.2	Matching assessment methods with the developmental level, the mathematical maturity, and the cultural background of the student
4.3	Aligning assessment methods with what is taught and how it is taught
4.4	Analyzing individual students' understanding of, and disposition to do, mathematics so that information about their mathematical development can be provided to the students, their parents, and pertinent school personnel
4.5	Basing instruction on information obtained from assessing students' understanding of, and disposition to do, mathematics

1. Math Classroom Observation in M elementary school

Topics: *Self-Assessment on Mathematical Understanding.* Level: Grade 3-B

(In the end of a class)
Teacher: "Tell me what you learned and found interesting or difficult in this lesson".
Student 1: "I have made a lot of careless mistakes in calculation".
Student 2: "I am very interested in the addition algorithm of four-digit numerals".
Student 3: "I have difficulty in carrying and borrowing in the addition and subtraction algorithms".
Student 4: "Addition with regrouping is easier to learn than subtraction with regrouping".
Student 5: "I am very interested in figures and games".

2. Teacher interview in N high school

Topics: *Performance Assessment.* Level: Grade 11

School Activities Records (SAR) is to get not only summative, diagnostic, and formative information on students' academic achievement, but also to get information about students' social behavior development. SAR contains such 13 main categories as personal information, educational background, school attendance, physical development, awards, certificates, career guidance, academic achievement, optional school courses, extracurricular activities, volunteer work and special experiences, social and moral development, and general remarks. We have three types in the *Total Entrance Examination Scores for Higher Education* in Korea (KICE 2000b).

A type: CSAT scores
B type: CSAT scores + the information in the High School Activities Records

C type: CSAY scores + The information in the High School Activities Records
+ Each Institute's own entrance examination scores

For academic achievement in mathematics, they use the midterm examination (40%), the final examination (40%), tasks and reports (10%), and performance assessment (10%) in N high school. But, most students get full marks in tasks and reports, and also in the performance assessment, if they hand in reports. So performance assessment is still unsettled.

VI. LEARNING ENVIRONMENTS

The evaluation items Standard 5 are in Table 7.

Table 7. <Standard 5> Learning Environments

1.1	Conveying the notions that mathematics is a subject to be explored and created both individually and in collaboration with others
1.2	Respecting students and their ideas and encouraging curiosity and spontaneity
1.3	Encouraging students to draw and validating their own conclusion
1.4	Selecting tasks that allow students to construct new meaning by building on and extending their prior knowledge
1.5	Making appropriate use of available resources
1.6	Respecting and responding to students' diverse interests and linguistic, cultural, and socioeconomic backgrounds in designing mathematical tasks
1.7	Affirming and encouraging full participation and continued study of mathematics by all students

1. Teacher interview in M elementary school

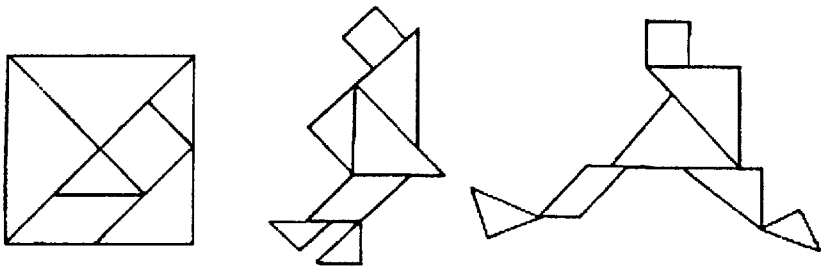
Topics: *Tangram on the wall of the school.* Level: Grade 3-B

Tangram is a game in which one makes several shapes using seven pieces; two big right-angled triangles, a middle-sized triangle, two small triangles, a square, and a parallelogram cut away from a 10cm × 10cm square. It is known that the game began in China about 2000 years ago and has remained in use both in Korea and worldwide.

It is a very interesting and useful game requiring the power of imagination, observation, and perseverance. There are numerous shapes, which can be made using seven pieces. There is a work of art, "The Seven Magicians (織女夢授圖, it means the figures which the Vega saw in a dream)" on the wall both in the subway station of the Kimpo International Airport and in this school.

It includes such fundamental types as a walking man, a running man, a water bird, a lotus blossom, 'small' in Chinese, a boat, 'six' in Chinese, a man reading a book lying

down, a chair, and a tower (Kim 1998; Kim 2000).



(a) Basic form (b) A walking man (c) A running man

Figure 3. A walking man and a running man

2. Teacher interview in N high school

Topics: *Students in the Library.* Level: Grade 11

The brilliant able students live in a dormitory, and 12th graders can use the library in the school for study, but in which there is no room for the 10th, and 11th graders. So they need to use a city or private library for study.

Students in big cities such as Seoul are inclined to enroll in private institutes to prepare for entrance examinations, but the students in small cities or rural areas are inclined to depend on their teachers.

VII. CONCLUSION

I can draw the conclusion from this study as follows. Firstly, the teaching of mathematics in both elementary and high school was very good in the standard of mathematical concepts, procedures, and connection. I could find such cases of connections as between bowling games and addition (Table 3), and between geometric sequences and animation (Figure 1).

Secondly, it is very good in the standard of mathematics as problem solving, reasoning, and communication. I could find cases of communication on the shape of plain figures and problem solving using a toilet roll (Figure 2).

Thirdly, it is not so good in the standard of promoting mathematical disposition. The teaching of mathematics is inclined to help students prepare for CSAT and enter higher grades rather than to demonstrate the value of mathematics as a way of thinking and its application in other disciplines and society.

Fourthly, it is good in elementary schools, but not in high schools regarding the

standard of assessing students' understanding of mathematics. The reason for this is regarded as the adhesion to the score of SAR in high school. Most students get full marks in tasks and reports, and also in the performance assessments, if they hand in reports. Therefore the performance assessment is still unsettled.

Fifthly, it is very good in elementary schools (Figure 3), but not so good in high schools regarding the standard of learning environments. The reason for this is that a great number of teachers in high school are in a state of functional fixedness. They do not want to change learning environments because they are not accustomed to activity-oriented learning and teaching.

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