Actual conditions of operating mathematics instruction in accordance with the current 7th national curriculum in Korea

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Ⅰ. The necessity and purpose of the study

The previous curricula in Korea were very abstract and general and their actual implementation was very authoritative and strongly controlled by the Ministry of Education. The documents of the current 7th curriculum are still authoritative but its actual implementation was changed. The current curriculum emphasizes an adapted curriculum with a view to achieving a curriculum that reflects individual student needs and regional specialization. The ultimate goal of the current curriculum is to raise the student's self-oriented learning abilities to the maximum. The adapted curriculum refers to the flexible management of the curriculum at the level of municipal and provincial educational offices and unit school including teachers (The Ministry of Education, 1997).

The current 7th national curriculum was newly announced in 1997. It was gradually implemented beginning in 2000, and now it is currently used in all schools. Six years have passed since its initial implementation and now it is necessary to examine how operation and management of instruction in school field has been affected by the current curriculum. This study examines the actual conditions of instruction provided by teachers while adjusting the curriculum with respect to the consideration given to individual student needs and regional specialization by focusing on the subject of mathematics. Ultimately, the purpose of this study is to assess how well mathematics instruction is being conducted in accordance with the goals of the new curriculum. Furthermore, this study suggests alternatives and supporting plans so that at the teacher level the current curriculum might be successfully implemented.

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Ⅱ. The understanding of the current national mathematics curriculum

To carry out this study, first of all, an overall understanding about the Korean national mathematics curriculum is required. Therefore, the curriculum will be briefly introduced as it relates to the current study.

The characteristics of the current mathematics curriculum

The current national mathematics curriculum is composed of total 20 steps (semesters) from first through tenth grade. This period is specially designated as the 'National Common Basic Education Period'. During this period, all students are obliged to study the subject of 'Mathematics'. Furthermore, eleventh and twelve graders have the option to choose at least two electives among six courses such as 'Mathematics Ⅰ', 'Mathematics Ⅱ', 'Calculus', 'Discrete Mathematics', 'Probability & Statistics', 'Applied Mathematics' according to their learning abilities, attitudes towards mathematics, and academic goals. The current mathematics curriculum requires teacher to:

(1) provide basic knowledge of mathematics
(2) emphasize student centered activities and communication
(3) foster interest and self-confidence in studying mathematics
(4) utilize instructional tools such as concrete manipulatives or technological devices in studying mathematics
(5) apply various instruction and evaluation methods

Goals and content of the current mathematics curriculum

The ultimate goals of mathematics are, in a word, to help students understand basic concepts, principles, and rules of mathematics, to observe and analyze the phenomena of matters mathematically, and to acquire mathematical abilities and attitudes needed for solving diverse problems related to realistic situations in a rational manner. This study focuses on the secondary school mathematics curriculum from the seventh to tenth grades, which are included in National Common Basic Education Period. The core mathematical content for each of these grades is shown in table 1.

Table 1. Mathematical content for grades seven through ten

Step / Domain	7-a	7-b	8-a	8-b
Number and operation	Meaning of set and operations of sets Properties of natural numbers Decimal and binary systems Integers and rational numbers		Representing rational numbers and decimals	
Geometric figures		Construction and congruence of figures Properties of plane and solid figures		Properties of triangles and rectangles Similarity of figures
Measure-ments		Polygons and measure of angles Length, area, and volume of geometric figures	Addition and subtraction of approximate values	
Probability and statistics		Distributions and their graphs Relative frequency and cumulative frequency distributions		Basic properties of probability
Letters and expressions	Using the letters and calculations of expressions Linear equations		Computation of expressions Simultaneous equations with two unknown Linear inequalities	
Patterns and functions	Direct & indirect proportions The concept of function and its graph			

Table 1. Mathematical content for grades seven through ten (continued)

Step / Domain	9-a	9-b	10-a	10-b
Number and operation	Square roots and real numbers Computing expressions	Correlations of two variables	Laws of set operations Statement Operations of real numbers Complex numbers	
Geometric figures		Pythagorean theorem and its application Relationship between circle and line Angles at the Circumference		Coordinates in the planes Equations of circles Relationship between two circles Parallel and symmetric translations
Measure-ments		Trigonometric ratios		Regions of Inequalities
Probability and statistics		Scattergram	Standard deviation	
Letters and expressions	Multiplication of polynomials Quadratic equations		Polynomials and their operations Factorization of polynomials Rational & irrational expressions Cubic and 4-degree equations Quadratic inequalities	
Patterns and functions	Quadratic functions			Correspondence Rational and irrational functions Trigonometric functions

Ⅲ. Methodology

The data for this study was collected using teacher and student questionnaires, classroom observations, and teacher interviews. Based on the analyzed results of the questionnaires, observations, and interview, this study examines how well actual in-class mathematics instruction is in line with the current curriculum which emphasizes flexible management of curriculum, student centeredness, and regional specialization (The Ministry of Education, 1997). These elements will be introduced briefly, prior to introducing the methodology used in this study (Sung et al. 2003).

Analysis elements

With respect to flexible management of curriculum, the Ministry of Education (1997) stated that each school or teacher has the flexibility to adapt mathematics instruction according to students' achievement level, teachers' concern, school environment, regional specialization, and so on. However, a noteworthy point is that Korean curriculum is a unified one on the national level dictating that all students in the same grade are required to study the same contents for a given school year. Because of this reason, it is not easy to change or reconstruct mathematical contents or materials by school or teacher. This study looks at how curriculum is managed at the teacher level.

Furthermore, the current mathematics curriculum emphasizes the importance of learner individuality, diversity, and interest in operating mathematics instruction. This study surveys whether mathematics teachers adapt their instruction to their students' learning abilities and attitudes with regards to mathematics. On the other hand, the current curriculum presents the minimum level of standards and it gives the teacher and school the discretion on how to achieve these goal. Consequently this study will investigate, with respect to regional specialization, to what extent teachers select or provide educational material and programs that reflect a special environment or culture of their school or region.

Finally, analysis of the results is presented based on the flexible management of curriculum, student-centeredness, and regional specialization. These criteria are not mutually exclusive. Therefore, they will be described and discussed integrally in the result part of this study.

Questionnaire

The questionnaire was conducted with the cooperation of all 16 national municipal and provincial educational offices. A total of 240 secondary schools throughout Korea were randomly selected representing approximately 5 % of all secondary schools in each region. The distribution by grade and school location of the participating schools is presented in table 2. The teacher questionnaire consisted of 19 selective items and one essay items. The main content of each item of the teacher questionnaire is presented in table 3. A total of 520 questionnaires were sent to mathematics teachers at each school. 59.4% (308 out of 520) of the questionnaires were collected. Only 17 out of the 308 respondents completed the essay part of the questionnaire.

Table 2. Surveyed school distribution by school grade and location

school Location	Number of Middle school (%)		Number of High school (%)				Total (%)	
			general		vocational			
Big city	114	(47.1)	20	(40.8)	5	(29.4)	139	(45.1)
Small city	71	(29.3)	16	(32.7)	5	(29.4)	92	(29.9)
Small town	57	(23.6)	13	(26.5)	7	(41.2)	77	(25.0)
	242	(100.0)	49	(100.0)	17	(100.0)	308	(100.0)

A total of 935 students (478 boys and 457 girls) participated in the survey. Among those students, the number of boys and girls was 478 and 457, respectively. The number of middle school students and high school students was 656 and 278, respectively, and the numbers of upper, middle, and low ranking students were 182, 612, and 141, respectively. The questionnaire items for students consisted of questions pertaining to their teachers' utilization of instructional materials, instruction and evaluation methods, and so on.

All of questionnaire items were primarily developed by the researchers of this study (Ina, et al. 2000, So, et al. 2000, Cho, et al. 2001, Huh, et al. 2003) and completed through a review of specialists belonging to two provincial educational offices, as well as specialists in the areas of curriculum, evaluation, and mathematics education.

Table 3. Questionnaire item summary

Main area of content	Main content of questionnaire items	Type of item	Number of item
General thing in instruction	Most important thing in managing math class	Multiple choice item	1
	Most difficult thing in managing math class		1
Instructional content	Whether or not adjusting the content in math class		1
	Reason for adjusting the content		1
	Method of adjusting the content		1
	Reason for not adjusting the content		1
Instructional materials (Textbook)	Whether or not reconstructing Textbook in math class		1
	Reason for reconstructing Textbook		1
	Method of reconstructing Textbook		1
	Reason for not reconstructing Textbook		1
Instructional methods	Instructional methods usually used in math class		1
	Instructional methods which are not used in math class and its reason		1
	Instructional materials usually used in math class		1
Evaluations	Evaluation methods usually used in math class		1
	Method of utilizing assessment result		1
	Most difficult thing in conducting evaluation		1
In-service training	Whether or not experiencing in-service training		1
	What are the issues of in-service training		1
	The degree of satisfaction of in-service training experiences		1
Opinion on improvement	Problem and improvement on educational environment, instructional materials, and in-service training	Essay type item	1
			Total 20

Classroom observation and teacher interview

A total of 8 schools among the sampled schools were selected for classroom observation in consideration of region and school size under the authority of 2 provincial educational offices. Classroom observations and teacher interviews were conducted for 12 mathematics teachers belonging to the eight schools. Information about the 12 teachers is presented in table 4. Classroom observation consisted of two researchers observing a one hour class. After the classroom observation, an hour-long informal interview was conducted with each teacher and audio taped. The observation and interview focused on flexible management of the curriculum, student-centered instruction, and regional specialization. There criteria are more fully presented in table 5 (Danielson 1997, NCTM 1991, NCTM 2000, So, et al. 2000).

Table 4. Information on classroom observations and teacher interviews

School year	Location	School	Teacher	Grade	Instructional content
Middle school	Gyeonggi-do	A	a-1	7	Addition of rational numbers
			a-2	8	Simultaneous linear equations
		B	b-1	7	Calculation of expressions
			b-2	8	Simultaneous linear equations
	Jeollanam-do	C	c-1	9	Factorization of quadratic equations
			c-2	7	Meaning of rational numbers
		D	d	8	Linear inequalities
High School	Gyeonggi-do	E	e	10	Properties of real numbers
		F	f-1	10	Factorization of cubic equations
			f-2	10	Factorization of cubic equations
	Jeollanam-do	G	g	10	Magnitude of real numbers
		H	h	10	Meaning of complex numbers

Table 5. The criteria for classroom observation and teacher interview

Elements of instruction	Characteristic of curriculum	The criteria for classroom observation and teacher interview
Instructional content (materials, methods, and evaluation)	Curriculum reorganization	Whether or not the content (materials, methods, and evaluation) are adjusted according to the current curriculum's intentions How the content (materials, methods, and evaluation) are adjusted
	Student centeredness	Whether or not the content (materials, methods, and evaluation) are adjusted reflecting students' learning abilities and attitudes on mathematics How the content (materials, methods, and evaluation) are adjusted
	Regional specialization	Whether or not the content (materials, methods, and evaluation) are adjusted while reflecting regional specialization How the content (materials, methods, and evaluation) are Adjusted

The limitations of the study

There are several limitations of this study. First, the effect of the overall supporting system of curriculum operation, classroom conditions, learning and attitude effect, and other various educational inside and outside factors were not addressed in this study. Second, the subject of classroom observations and interviews were conducted with teachers from only two of the 16 educational offices. Third, most of teachers who permitted their class to be observed seemed to be passionate about teaching mathematics and to have a deep knowledge of mathematics. In addition, they had positive attitudes towards this study. It is unlikely that these teachers accurately represent

the typical national secondary school mathematics teacher in Korea. Fourth, this study includes the possibility of bias on the part of the researcher in favor of flexible management of mathematics curriculum by individual teacher. Finally, there is doubt about the degree to which the cases in this study are representative of other cases. Nonetheless, the results might help us understand other cases and lead to relationships that can be further studied in other ways.

Ⅳ. Actual conditions of carrying out mathematics instruction in accordance with the current curriculum

Based on the results of the questionnaire, classroom observations, and teacher interviews, this study investigated whether mathematics instruction was being done in accordance to the intent of the current curriculum. The analysis results are presented in terms of instructional content, materials, methods, and evaluation.

Instructional content

According to the results of classroom observations and teacher interview, most of teachers were carrying out instruction in accordance with the instructional objectives and content presented in textbook. In the interview, they mentioned that they did not adjust instructional content even if some of their classes contained students with very high or low mathematical abilities. In a word, it seems that teachers do not feel much need for adjusting instructional objectives at teacher level.

Teachers who responded negatively about the adjustment of instructional content in the questionnaire responded similarly during the interview. The number of teachers who responded that they did not adjust instructional content was more than half (165 out of 307). In contrast, 142 teachers (46.3%) responded that they adjusted the content. Only one teacher did not respond to this question.

The 165 teachers who responded negatively were asked to list their reasons in order of importance for not adjusting instructional content. Fifty four teachers (32.7%) said they did not adjust the instructional content because the content presented in the curriculum was appropriate, 46 teachers (27.6%) said it was because adjusting the content was not necessary in mathematics, and 39 teachers (23.5%) said all of the content presented in the curriculum should be taught. Likewise, the 142 teachers were asked to list three

reasons in order of importance for why they adjusted the content. As shown in table 6, 41 teachers (28.9%) responded that they adjusted the content out of consideration of the students' interest and concern, and 37 teachers (26.0%) indicated that it was to reflect connection of the content according to the properties of the mathematics. Next, 36 teachers (25.4%) said they adjusted the content because the content were not appropriate for students' mathematical achievement level.

Table 6. Reasons for adjusting the content in mathematics class

Examples for reasons of adjusting objectives	Frequency of responses (%)					
	1st priority		2nd priority		3r priority	
For reflecting regional specialization	5	(3.5)	0	(0.0)	8	(5.7)
For reflecting the connection of the content according to the properties of mathematics	37	(26.0)	30	(21.3)	21	(15.0)
For controlling difference in students' achievement level	36	(25.4)	30	(21.3)	15	(10.7)
For considering students' interest and concern	41	(28.9)	45	(31.9)	25	(17.9)
For dealing with content involving realistic situations	4	(2.8)	7	(5.0)	22	(15.7)
For dealing with new knowledge and information	0	(0.0)	2	(1.4)	5	(3.6)
Because of insufficient school environment	0	(0.0)	2	(1.4)	4	(2.9)
Because of lack of class hour	0	(0.0)	7	(5.0)	15	(10.7)
For emphasizing problem solving process and students' attitude on mathematics	18	(12.7)	18	(12.7)	24	(17.1)
Others	1	(0.7)	0	(0.0)	1	(0.7)
	142	(100.0)	141	(100.0)	140	(100.0)

Here, if the reason for adjusting instructional content is compared with the reason for not doing so, the teachers who answered "yes" tended to intensively consider more aspects of student-centeredness, in comparison with the teachers who answered "no". After all, it can be said that most teachers are adjusting the content in an effort to reflect students' achievement level and also to get students interested in studying mathematics.

The 142 teachers who responded positively were asked to choose list in order of priority how they adjusted the objectives. The most common first choice (36.6%) was for teacher to change the order of content by separating some content. The next most common method of adjustment (26.8%) was for teacher to change the order of content by putting several content (concepts) together. Other method was for teachers to skip a few objectives without dealing with them (19.0%).

According to the results of the classroom observations and teacher interviews, only two of 12 teachers had been adjusting the content by changing the order of content. Teacher c-2 at middle school C used to teach statistics just before summer vacation, which is suggested to be dealt with in the fall semester in the curriculum documents. (In Korea,

the curriculum presents what is the content to be dealt with per semester.) Because statistics usually requires a lot of time for solving problems and performing tasks, it is appropriate for these tasks to be given as a vacation assignment. In the case of Teacher b-1, it is to deal with the content that will be dealt with in upper grades. Namely, new concepts, which are to be dealt in an upper school year, are dealt with earlier in the school year. However, the Teacher b-1 does not provide the necessary instruction so that students understand the principles or rules of the new concepts. Instead, they just introduce formulae related to the concepts. By taking this approach, teachers might overlook an important thing that when the time comes for students to study the principles or rules about the new concept step by step, students are rather apt to neglect a teacher's lecture on the concept.

Instructional materials

The number of teachers who responded that they reconstructed Textbook in teaching mathematics was 205 (66.6%). In contrast, 98 teachers (31.9%) answered that they did not reconstruct Textbook. Five teachers did not respond to this question. The 205 teachers who responded positively were asked to list in order of importance the reasons they reconstructed Textbook (Table 7). The most common reasons of reconstructing Textbook were that the content was not appropriate for students' achievement levels (28.8%), to reflect the properties of mathematical content by chapter (24.4%), and to consider students' interest and concern (22.9%).

Through the interviews and classroom observation, a few teachers deal with the content presented in the curriculum but include a variety of issues or problematic situations with which students would be concerned. Teacher d of middle school D mentioned that he instructed the class utilizing diverse material that is easily accessible from newspapers or the Internet. For instance, when he deals with equation problems, he introduces realistic problem situations like the cost of buying school materials or snacks. In this situation, students are likely to participate in class much more actively than when they solve typical equation problems. Also, teacher c-2 of middle school C stated that he incorporates things such his students' favorite singers, actors, and sportsmen or issues of mathematical history into his lessons. According to this teacher, his students become more active than usual when he includes such material.

Through the interviews it was observed that two teachers sometimes deal with mathematical problems involving situations of regional specialization. For example, teacher e of high school E mentioned that when he taught statistics in his class he

includes real life farm situation such as the amount of rice production or the area of rice farming. However, according to teacher f-2 of high school F, because of preparation for college entrance examination, mathematics teachers in high school have difficulty in dealing with problems stimulating students' interest or reflecting the regional specialization.

Table 7. Reasons for reconstructing Textbook in mathematics class

Examples for reasons of adjusting content	Frequency of responses (%)					
	1st priority		2nd priority		3r priority	
For reflecting regional specialization	5	(2.4)	1	(0.5)	1	(0.5)
For reflecting the properties of content	50	(24.4)	27	(13.3)	25	(12.5)
For controlling difference in students' achievement level	59	(28.8)	29	(14.3)	25	(12.5)
For considering students' interest and concern	47	(22.9)	67	(33.0)	28	(14.0)
For dealing with content involving realistic situations	9	(4.4)	18	(8.8)	19	(9.5)
For dealing with new knowledge and information	0	(0.0)	2	(1.0)	3	(1.5)
Because of insufficient school environment	0	(0.0)	0	(0.0)	3	(1.5)
Because of lack of class hour	2	(1.0)	4	(2.0)	13	(6.5)
For emphasizing problem solving process and students' attitude on mathematics	15	(7.3)	33	(16.3)	39	(19.5)
For integrating mathematics into other subjects	1	(0.5)	1	(0.5)	6	(3.0)
Because of inappropriate order in content	3	(1.5)	5	(2.4)	4	(2.0)
Because of insufficient amounts of content	13	(6.3)	16	(7.9)	32	(16.0)
Others	1	(0.5)	0	(0.0)	2	(1.0)
	205	(100.0)	203	(100.0)	200	(100.0)

On the other hand, teachers were asked on the questionnaire to list three kinds of instructional materials they used in their mathematics classes. The results are shown in table 8. Three teachers among 308 persons did not answer the question. Table 8 shows that 236 teachers out of 305 teachers (77.4%) answered that the textbook and teacher guidebook were their main instructional materials, whereas 69 teachers (22.6%) answered that sometimes they use other instructional materials with mathematics textbook in their class. Furthermore, a total of 945 students were asked to select materials that their mathematics teachers often used in class in order of frequency. 97.1% of the students listed the textbook as most often used instructional material. The reason for the discrepancy of the primary instructional material according to the teachers and students could be that students might have had a fixed concept that mathematics is an originally static subject with priority given to drill and practice problem solving activities. Because of this reason, even though teachers prepared and used some interesting materials, these things might not have been new or attractive to the students.

Table 8. Instructional materials mainly utilized in mathematics class

Examples for the types of instructional materials	Frequency of responses (%)		
	1st priority	2nd priority	3rd priority
Textbook and teacher's guide book	236 (77.4)	16 (5.3)	14 (4.6)
Materials of solving problems	19 (6.2)	80 (26.3)	45 (14.8)
Materials developed by research center or educational office	10 (3.3)	50 (16.5)	33 (10.9)
Materials developed by teachers	8 (2.6)	34 (11.2)	25 (8.2)
Materials developed by his own or peers	10 (3.3)	39 (12.8)	36 (11.9)
Book related to mathematics	4 (1.3)	14 (4.6)	35 (11.6)
Materials related to ICT	13 (4.3)	34 (11.2)	42 (13.9)
Newspaper, other materials	0 (0.0)	0 (0.0)	2 (0.7)
Materials on Internet	3 (1.0)	36 (11.8)	57 (18.8)
Materials published or announced from Educational Broadcasting System(EBS)	1 (0.3)	1 (0.3)	13 (4.3)
Others	1 (0.3)	0 (0.0)	1 (0.3)
	305(100.0)	304(100.0)	303(100.0)

Instructional methods

The curriculum recommends that mathematics be taught using a variety of instructional methods: however, the reality is that the number of different types of materials used is quite limited. There might be a few reasons for this. The results of the teacher interviews show that by and large it is not easy for teachers to use special or dynamic instructional methods because the subject of mathematics is mainly taught by the teacher explaining concepts accompanied by the students solving problems with paper and pencil.

In the questionnaire, teachers were asked to list three instructional methods in order of frequency that they use in class. The results are shown in table 9. Most of the teachers (77.3%) indicated that they mainly taught through explanatory instruction. A much smaller percentage of teachers, 33 teachers (11.8%), preferred small group activities comprised of a few students, while 25 teachers (8.2%) preferred student presentations and demonstrations. Students, on the other hand, indicated that the methods used were not as varied. On the student questionnaire, students were asked to check whether or not their mathematics teachers used a variety of instructional methods. 91.2% of the students indicated that there was not much variety in terms of the instructional methods used by their teachers.

Table 9. Instruction methods usually used in mathematics class

Examples for instruction methods	Frequency of responses (%)

usually used in mathematics class	1st priority	2nd priority	3rd priority
Lecture type instruction by teachers' explanation or demonstration	235 (77.3)	23 (7.6)	24 (8.1)
Students' activities involving demonstration or presentation	25 (8.2)	110 (36.2)	40 (13.4)
Carrying out performance tasks	2 (0.7)	49 (16.1)	80 (26.8)
Visiting special places outside school	0 (0.0)	3 (1.0)	2 (0.7)
Activities by special roles	1 (0.3)	0 (0.0)	1 (0.3)
Group activities involving discussion	33 (10.9)	85 (27.9)	93 (31.2)
Utilizing diverse materials through Internet	8 (2.6)	34 (11.2)	55 (18.5)
Others	0 (0.0)	0 (0.0)	3 (1.0)
	304(100.0)	304(100.0)	298(100.0)

The results of classroom observation and teacher interview were slightly different from the results from the questionnaire. This may be due to the possibility that most of teachers participated in this study might be more passionate about teaching mathematics than their fellow mathematics teachers. For example, teacher d of middle school D said that when approaching a 'new' mathematical concept he instructed his students to communicate among themselves through small group activities. When studying a new concept, students discussed aloud sharing their opinions about the new concept. When the teacher explains the concept after such discussion, students seemed to understand it more soundly. After such a process the students are usually able to more easily individually solve problems related to the concept. However, the teacher of this class denied the need for any other special teaching methods in mathematics class.

In addition, instruction involving computer use in class could be also discussed. For example, it was shown through classroom observation that teacher h of high school H tried to introduce the concept of complex numbers while showing various patterns of complex numbers using a computer. The teacher was not familiar using the computer and his poor handling of the computer resulted in his students becoming noisy in the class. However, it was shown that by utilizing a computer, students seemed to be more interested in learning such an unfamiliar and abstract concept as complex numbers. On the other hand, through another interview, teacher e of high school E said that he videotapes his lectures on explaining a new concept in advance and so that in regular class hour students can view the lecture in case they have some difficulty with the new concept. For example, this teacher usually introduces a new concept and then asks his students to solve problems related to the concept. Students who have difficulty in solving the problems are then required to watch the lecture on video. The teacher mentioned that his students seemed to understand the concept while hearing it again through watching video and to solve the given problems more successfully.

The teacher interviews also showed that instructional methods involving game activities could be used. For example, teacher a-1 of middle school A said that he used some game activities whenever he introduces a new concept. Teacher a-1 presents mathematical problems so that they resemble computer game strategies such as those used in StarCraft or Lineage. He mentioned that his students tended to participate in class more actively when he used this method. Also teacher b of high school B said he sometimes tried to change the boring and formal atmosphere of mathematics class into a more lively and interesting one by patterning his classes after famous television quiz programs such as ' Golden Bell'.

Evaluation

The results of teacher interviews revealed that in general teachers had negative opinion about the evaluation system carried out in school. The curriculum strongly recommends that the evaluation of the students' mathematical ability should be conducted using not only a multiple choice type tests but also other types of tests. However, teachers stated that they were not sure what types of evaluation methods were appropriate under certain circumstances and they did not know the strengths or weaknesses of each evaluation method. Therefore, teachers tended to prefer the evaluation methods that they have always used.

Teachers were asked to indicate three evaluation methods used in their class based on frequency of use. As shown in table 10, the most common evaluation method was multiple choice type and single answer type tests (85.2%) followed by essay type items (6.23%) and performance tasks (4.3%).

Table 10. Evaluation methods utilized in mathematics class

Evaluation methods utilized in mathematics class	Frequency of responses (%)		
	1st priority	2nd priority	3rd priority
Multiple choice and short answer types test	260 (85.8)	20 (6.7)	4 (1.4)
Essay type test	19 (6.2)	142 (47.5)	21 (7.3)
Performance assessment	13 (4.3)	99 (33.1)	100 (34.7)
Observation on learning attitude	4 (1.3)	32 (10.7)	132 (45.8)

Students' self assessment	2 (0.7)	0 (0.0)	5 (1.7)
Oral test	0 (0.0)	1 (0.3)	5 (1.7)
Presentation	2 (0.7)	5 (1.7)	18 (6.3)
Others	3 (1.0)	0 (0.0)	3 (1.1)
	303(100.0)	299(100.0)	288(100.0)

The evaluation methods utilized in mathematics class are still traditional paper and pencil tests, but gradually tests through observation of students' attitudes and performance on short term or long term tasks are being utilized. The results of teacher interview showed that teachers could determine the students' difficulty in understanding some mathematical concepts through performance assessment. For example, teacher b-2 at middle school B and teacher c-1 at middle school C mentioned that they sometimes gave their students a short term task that could be completed through small group activities during a one hour class. The teachers stressed the importance and necessity of performance assessment, which could supplement students' deficiencies by precisely checking and examining their performance process. But, these two teachers used different scoring methods for evaluating student performance in the small group activities. Teacher b-2 assessed performance as a group, whereas teacher c-1 evaluated the students within a group individually based on the degree of cooperation and positive attitude in the group.

In Korea, teachers have more latitude in using their subjective judgment of a student's problem solving ability or performance process in elementary school and middle school than they do in high school. In high school, however, there is not much room for the subjective judgment by the teacher because evaluation is directly related to the college entrance examination system. Therefore, in order to successfully utilize various evaluation methods involving teacher's individual and subjective judgments, it is imperative that any judgment made by teachers be accurate, valid, just and reliable.

In the questionnaire, teachers were asked to list how they utilized the results of student assessment, i.e. test scores and quizzes. 184 teachers among 304 teachers (60.5%) used the assessment result in order to grasp individual students' achievement level on mathematics. 89 teachers (29.3%) used it for providing feedback for their learning status. Only 20 teachers (6.6%) said that they used assessment result as a basic data for improving their instruction.

Discussion

The effect of the new curriculum on instructional content was minimal. Most teachers

continued to teach the content presented in textbook as they always have. However, some teachers adjusted the content and instructed it in understandable ways for students. In addition, there was no case of adjusting instructional content in reflection of regional specialization. Most teachers seemed to think negatively about the responsibility for adjusting the national curriculum instructional content resting at the teacher level and to think that their responsibility might have dealt with textbook faithfully. As above, mathematics teachers generally seemed to prefer to operate their instructions according to instructional content presented in the curriculum or textbook. However, teachers seem to think that in their class they have the right to adapt their instruction by reconstructing Textbook so that they can include interesting issues and present mathematics in realistic contexts.

On the other hand, with respect to instructional methods, the teacher and student surveys show that teacher-centered explanatory method is preferred. However, the teacher interviews and observations showed that a few teachers are putting more importance on learners' interest or concern and to promote an active learning attitude. These teachers are making an effort to include diverse activities on their own in their class and it can be surmised that student reaction might be positive. This allows us to glance at the situation of mathematics class in which it escapes teacher-centered traditional type of instruction while student-centered instructional method is prevailing.

Finally, the results of this study showed that with respect of the methods of evaluation, it was quite different with the results in the other aspects of instructional content, materials, and methods. That is, recently mathematics teachers have a more focus on students' centeredness in their instruction for the sake of enhancing their mathematical ability. But, in the aspect of evaluation, teachers still tend to use an assessment result as only a standard for judging students' individual mathematical achievement level. As emphasized in the current curriculum (The Ministry of Education, 1997), it should be strongly recommended to teachers that evaluation be used to inform teachers how they can modify their instruction to better meet the ultimate goals of mathematics education as well as to estimate the degree or level of students' achievement in mathematics.

Ⅴ. Suggestions for a successful operation of mathematics instruction

In this chapter, in addition to the aspects of instructional content, materials, methods, and evaluation discussed up to now, it will be suggested what the teachers' expectation are in terms of the development of instructional materials, establishment of educational

environments, and enforcement of in-service training. These three factors were included in one essay item of the survey as shown in Table 3. This item requested the teacher to answer what are problems found at the teacher level and plans for carrying out mathematics instruction more successfully in accordance with the current mathematics curriculum.

Development of instructional materials

According to the results of the essay item in the questionnaire, 12 out of 17 teachers said that the amount of material taught according to the new curriculum were less than that required under the previous curriculum. However, they still have trouble covering all the material since the new curriculum requires mathematics instruction to be more student-centered. Making instruction more student-centered requires more preparation time for making diverse and interesting lectures as well as the time to prepare supplementary instructional materials to support such activities. The teachers insisted that the total number teaching hours and other responsibilities should be reduced in order to improve the quality of instruction. But, in contrast, a couple of teachers seemed not to be as concerned with including student-centered activities in their instruction; therefore, they were not very worried about the shortage of class hours.

In Korea, the belief that all students should be able to solve all problems presented in mathematics textbook has prevailed. This belief may have come from the extremely excessive competition among students on the college entrance examination. Because of this reason, it has been well known that many teachers would expect new differentiated mathematics textbooks to be developed at the national level so that with the selected mathematics textbook in accordance with students' own achievement level, they are able to understand some content and to solve problems related to the content. It was the exactly same what the twelve teachers among 17 who responded to the essay type item said. With a view to attaining a long cherished desire for such a request, one of the important issues not to be overlooked might be a careful application of a differentiated evaluation system in the school field, which should be on the basis of sound understanding of the system. In addition, the seven teachers among 17 expect that a textbook should contain a variety of problems involving more realistic situations or contexts.

Establishment of educational environment

A recommendation for utilizing instructional tools in mathematics class was stressed in the previous and current mathematics curriculum (The Ministry of Education, 1992, 1997). As a result, mathematics teachers' concern and response about these tools has been very encouraging. In this study, most of teachers among 17 teachers said that by utilizing instructional tools such as commercial manipulatives and technological devices, instruction would be more efficient. They insisted that the use of these instructional tools be implemented in the school field as soon as possible.

The results of teacher interview revealed that the growing need for teacher assistant can play a role of staff-in-charge for administrative affairs and supplementary classes for slow or retarded learners because they are able to help such students learn step by step. Also, most of teachers who responded to the essay item proposed that a mathematics lab or study room should be established in every school so that teachers could share their ideas and to reconstruct or develop new materials in collaboration with other teachers.

Enforcement of in-service training for training

The survey results also suggested the need for improved in-service teacher training. Some of the issues and subjects pertaining to in-service training lectures were not appropriate for improving the quality of instruction, although the lectures comprised of many subjects relevant to mathematics education have been conducted through both duty training and general selective training courses. Only slightly more than one-third of the respondents (36.8%) indicated that they had participated in in-service training lectures. Among the many lectures for mathematics teachers, one of the most popular is about understanding the mathematics curriculum. However, anecdotal evidence suggests that many teachers still complain about not having an adequate understanding of management system or new content of the revised curriculum. This sentiment was also mentioned in the essay and interviews conducted for the current study. In addition, the results of the essay indicated that the in-service training lectures were usually conducted by professors, who tended to emphasize theories related to mathematics education. But, teachers thought that such theory-oriented lectures were not very helpful for carrying out mathematics instruction in their class.

After all, it was revealed that, in order to help teachers to carry out mathematics instruction efficiently, diverse in-service training courses focusing on practice-oriented lecture were requested.

Discussion

In conclusion, the following general guidelines came out of the results of this study. At first, it is required that teachers recognize the necessity of differentiated curriculum based on learners' achievement level and their interest and attitudes. Secondly, generally some teachers still confuse the curriculum documents with the textbook. Even though a few teachers know the fact that the textbook is developed based on curriculum documents, they think that thereby just following the textbook without consideration of curriculum documents is a good or the best way. However, the viewpoint of a difference between curriculum documents and textbook should be straightened out among teachers. Thirdly, teachers should try to reinforce and improve their professionalism as mathematics teacher through in-service training. To accomplish this, on the level of school unit, efforts should be made to reduce the administrative duties of teachers and provide instructional tools in class for carrying out mathematics instruction efficiently and to provide a study room in school so that mathematics teachers can share their ideas and their work cooperatively.

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