Chapter 2

Mathematics Curriculum in Korea

Paik, Suk-yun

Seoul National University of Education

Abstracts

The purpose of this paper is to introduce Korean school mathematics curriculum. For this purpose we intended to show general features and characteristics of the recent Korean school mathematics curricula as well as the brief shape of the present mathematics curriculum. Firstly, we described mathematics curriculum changes happened in the late 20th century. Secondly, we introduced the brief shape of the current mathematics curriculum and its special characteristics compared to previous curricula. And finally, we discussed the direction of future curriculum revision and also the proper trends of future mathematics curriculum.

I. Introduction

Korean society is still noted for its homogeneity. In particular, like most Asian nations, Korea has a remarkably uniform educational system. This uniformity of an educational system from the elementary school to high school level clearly brings out it's characteristics by means of the school curriculum. According to the current curriculum there is no differentiation in mathematics syllabi until the 10th grade. This homogeneity in an educational system demands sacrifices from the able, who may be left unchallenged, and on the other hand from the below average too, who will have to struggle hard to keep up with their classmates.

Moreover, most students are highly expected to exceptionally achieve high levels in mathematics among the school subjects by both their parents and teachers who believe mathematics would operate as a decisive factor for insuring the success in any kinds of future entrance examination. Such social climate leads many students to attend private educational institutes operating in the evenings and on weekends.

However, recently Korean students' achievement level in mathematics have frequently held high ranks in many international studies of students' attainment, and on the other hand, the Korean information industry along with other industrial areas have rapidly progressed as a leading economic and industrial power in Asia. These promising phenomena seem to provide ample motivation for other countries to have interests in the study of Korean mathematics education, particularly in the Korean mathematics curriculum.

II. Mathematics Curriculum Changes in the Late 20th Century

The Korean mathematics curriculum has been uniformly maintained and it's overall revision process has been determined by national level planning. During the latter half of the century Korean mathematics curriculum has been revised six times since the liberation of Korea in 1945. The following [Table 1] briefly illustrates mathematics curriculum changes in the late 20th century in Korea.

[Table 1] Brief History of Mathematics Curriculum

Curriculum	Period	Main Focus
1st Curriculum	1955 –1963	Real Life Centered
2nd Curriculum	1964 –1972	Mathematics Structure Centered
3rd Curriculum	1973 –1981	"New Math" Oriented
4th Curriculum	1982 –1988	"Back to Basics" Oriented
5th Curriculum	1989 –1994	"Problem Solving" Oriented
6th Curriculum	1995 –1999	Problem Solving and Informational Society Oriented
7th Curriculum	2000 -	Learner Centered

The 1st mathematics curriculum can be characterized as real life experience centered curriculum, which was influenced by Progressivism in the U.S. which valued learner's experience in real life. Because this curriculum regards the school subject mathematics as a tool for the betterment of living, the structure or the system of mathematics was ignored. Thus, the contents of the mathematics curriculum were in low level and mainly life-problem oriented.

Lenience and ignorance in the mathematics structure of the 1st mathematics curriculum caused the decline of students' mathematics achievement, which necessitated the 2nd curriculum revision. The focus of the 2nd curriculum was systematic learning, which was based on Herbart's Essentialism(Park 1998). The 2nd curriculum placed great value on the logical and theoretical aspects of mathematics, and pursued the improvement of students' mathematical abilities.

The 3rd mathematics curriculum was influenced by New Math, which occurred as the result of the discipline centered curriculum and mathematics modernization movement. The 3rd curriculum attempted to introduce abstract but fundamental ideas (for example, sets) early in the curriculum and to continually return to these ideas in subsequent lessons, relating, elaborating, and extending them. Bruner's discovery learning was also crucial element in the 3rd curriculum.

The 4th mathematics curriculum started from the failure of New Math and the emergence of the Back to Basics Movement in the U. S. Students' basic computation skills were weakened due to the structural approach to mathematics of the 3rd curriculum. Thus the 4th curriculum reduced contents, lowered the level of difficulty, and emphasized obtaining of minimal competencies in mathematics. The 5th mathematics curriculum basically maintained the tradition of the 4th curriculum. The main direction of revision was to emphasize students' mathematical activities in mathematics class, and to consider affective aspects of learning mathematics. From this period, keeping in step with the current social trends, the mathematics curriculum started to take the information society into account.

The 6th mathematics curriculum is not so much different from the previous one. The 6th curriculum increasingly stresses mathematical thinking abilities by the way of fostering mathematical problem-solving abilities. This curriculum period especially emphasized the necessity of discrete mathematics in school mathematics.

III. The 7th Mathematics Curriculum

Now Korean school mathematics is in the middle of the 7th new mathematics curriculum, which has already been applied to every school level up to high school. The core characteristics of the 7th mathematics curriculum are represented by the implementation of 'differentiated curriculum', which can be one of the alternative ways of alleviating such problems of our education as instruction of mathematics is carried out without considering students' abilities and aptitudes in the classroom. The following will show the rationale for the revision of the 6th mathematics curriculum and the main features of the current 'differentiated curriculum', namely the 7th mathematics curriculum.

1. Rationale for the Revision of the 6th Curriculum

Describing the special features of the 7th mathematics curriculum compared to those of the previous curricula could be an answer to what is the rationale for the revision of the 6th mathematics curriculum. The 7th mathematics curriculum has several features basically distinguished from those previous mathematics curricula.

First of all, the most important and unique trial in the 7th mathematics curriculum is to shift the subjecthood of mathematics curriculum from the instructors to the learner. The 7th curriculum set up a direction basically to consider the learners' stand points such as learners' abilities and psychology while they are learning mathematics. In brief, the 7th curriculum is 'learner centered', which actively plans to implement the curriculum in a stepwise and level-referenced manner, emphasizing learner's voluntary and positive learning activity, and provoking learner's interests in mathematics.

Secondly, with an intent to optimize the quantity of school mathematics contents, the 7th curriculum tried to reduce 30% of former curriculum period mathematics contents. It is a well-known fact that the level and the quantity of school mathematics contents in Korea is relatively high compared to those of other countries. For such reasons, mathematics has been continuously blamed for as the main factor causing huge scale private lessons. However, these contents reducing attempts were only to bring about 10% reducing result.

The third special feature of the 7th curriculum is that it is expected to offer various mathematics subjects for the 'Elective Period'(for grade 11 and 12). For the selective mathematics subjects, 'Calculus', 'Probability and Statistics', and 'Discrete Mathematics' are added compared to the 6th mathematics curriculum. In fourth, there has been the reconciliation of the content domain names of school mathematics. The domain names have been heterogeneous according to each school level. But the 7th curriculum integrated the domain names homogeneously up to 10th grade disregarding the school levels. This is because of the 7th curriculum's trial to unify mathematics curricula of grade 1 through grade 10.

The last special feature of the 7th Curriculum pertains to how computers and calculators can be implemented in the mathematics curriculum and classroom. The 6th curriculum has already mentioned and encouraged the utilization of calculators for specific mathematics content. However in actually, teachers and parents rarely allow the active use of such technologies. On the contrary , the 7th curriculum tried to actually practice it in the mathematics classroom.

2. General Features of the 7th Curriculum

The Korean educational period consists of the two periods: ‘Compulsory Period(10 years from grade 1 to 10)’ and ‘Elective Period(2 years from grade 11 to 12)’. Otherwise, to prevent the redundancy and inefficiency of math contents, and to pursue the consistency of mathematics education, previous school level distinction is abolished even though the distinction in terms of administration still exists. Mathematics in the ‘Compulsory Period’ is organized in a stepwise and level-referenced manner that allows the teacher to consider the rate of the student's cognitive development and to thereby select core contents of the curriculum based on a learning hierarchy and difficulties. Moreover, the curriculum would separate 'basic' and 'enriched' content to make it possible for each student to maintain his or her own learning pace and to have a creative learning experience.

In the mathematics curriculum, 'level based differentiated curriculum' manner is applied because the school subject mathematics is relatively hierarchic, structured, and creates severe individual differences among pupils in the process of instruction. Thus, the mathematics curriculum is organized and implemented in a 'level based differentiated curriculum' manner in the ‘Compulsory Period’(from grade 1 to 10; 10 levels and each level with 2 sub-levels A and B). In ‘Elective Period'(from grade 11 to 12; 2 levels and each level with 2 sub-levels A and B), the 'subject selection differentiated curriculum' manner is applied for the students to select their own subjects based on their own needs and capacities. In the mathematics curriculum, this curriculum manner is applied to all the students in grades 11 and 12. In these two grades various mathematics subjects are available such as 'Practical Mathematics,' 'Mathematics I,' 'Mathematics II,' 'Calculus,' 'Probability and Statistics,' and 'Discrete Mathematics'.

3. The Flow and Basic Structure of the 7th Curriculum

For each of the two educational periods, i.e. 'Compulsory Period(10 years from grade 1 to 10)' and 'Elective Period'(2 years from grade 11 to 12), corresponding mathematics curriculums are developed. Each of these two mathematics curriculums are composed of 5 parts, such as characteristics, objectives, contents, teaching & learning methods, and evaluation.

[Table 2] The Flow of the Mathematics Curriculum

Compulsory Period		Elective Period
Grade 1 through 10	→	Grade 11 and 12
Mathematics		Practical Mathematics, Mathematics I, Mathematics II, Calculus, Probability & Statistics, Discrete Mathematics

During the 'Compulsory Period(from grade 1 to grade 10)', mathematics is compulsory, which means all students are required to take the same mathematics courses. But, during grades 11 and 12, tracking in mathematics is available as [Table 2] shows.

4. School Time Allotment by Subject, Extracurricular and Discretional Activity

A. 'Compulsory Period' School Time Allotment

In the following [Table 3], we can find how the ‘Compulsory Period’ mathematics curriculum is constituted in yearly time allotment compared to those of other school subjects and activities. The school time allotted to Mathematics is 131 hours in average per year, which is the largest amount of time allotment second only to Korean Language, of which time allotment is 188 hours in average per year. However, mathematics has steady time allotment tendency throughout the period being compared to decreasing the time allotment tendency of Korean Language.

[Table 3] 'Compulsory Period' School Time Allotment
by Subject, Extracurricular Activity, and Discretional Activity

School level Grade Subject		Elementary						Junior High			Senior High		
		1	2	3	4	5	6	7	8	9	10	11	12
Subject Area	Korean	Korean . 210, 238 Mathematics 120, 136 Disciplined Life 60, 68 IntelligentLife 90, 102 Pleasant Life 180, 204 We are Freshmen 80		238	204	204	204	170	136	136	136	Elective Courses	
	Ethics			34	34	34	34	68	68	34	34		
	Social Studies			102	102	102	102	102	102	136	170		
	Mathematics			136	136	136	136	136	136	102	136		
	Science			102	102	102	102	102	136	136	102		
	Practical Arts			□	□	68	68	68	102	102	102		
	Physical Ed			102	102	102	102	102	102	68	68		
	Music			68	68	68	68	68	34	34	34		
	Fine Arts			68	68	68	68	34	34	68	34		
	English			34	34	68	68	102	102	136	136		
Discretional Activity		60	68	68	68	68	68	136	136	136	204		
Extracurricular Activity		30	34	34	68	68	68	68	68	68	68	8 units	
Grand Total		830	850	986	986	1,088	1,088	1,156	1,156	1,156	1,224	144 units	

* Each number means the minimum number of total instructional hours per year (counted as 34 weeks). * In case of grade 1, one school year is counted as 30 weeks. * One instructional hour covers 40, 45, and 50 minutes with respect to elementary, junior high, and senior high school.

B. 'Elective Period' School Time Allotment

The following [Table 4] shows how the high school 'Elective Period' mathematics curriculum is constituted in terms of yearly time allotment compared to those of the other school subjects and activities.

[Table 4] 'Elective Period' School Time Allotment

by Subject, Extracurricular Activity, and Discretional Activity

Division		National Common Basic Subjects	Elective Subjects	
			General Elective Subjects	**Enrichment Elective Subjects**
Subject	Korean Ethics Social Studies	Korean (8) Ethics(2) Social Studies(10)	Korean Language Life(4) Civil Ethics(4) Human Society & environment(4)	Conversation(4), Reading(8), Composition(8), Grammar (4), Literature(8), Ethics & Ideology(4), Traditional Ethics (4), Korean Geography(8), World Geography(8), Economical Geography(6), Korean Modern History(8), World History(8), Law & Society(6), Politics(8), Economics(6), Society & Culture(8)
	Mathematics Science Technology Home economics	Mathematics (4) Science(6) Technology Home economics(6)	Practical Mathematics(4) Life and Science(4) Information Society and Computer(4)	Math I(8), Math II(8), Calculus(4), Probability & Statistics(4), Discrete Math(4), Physics I, II(4,4), Chemistry I, II(4,4), Biology I, II(4,4), Geology I, II(4,4), Agriculture Science(6), Industrial Technology(6), Administration(6), Sea Science(6), Home Science(6)
	Physical Education Music Fine Arts	Physical Education Music Fine Arts	Physical Education Health(4) Music & Life(4) Fine Arts & Life(4)	Theory of Physical Education(4), Practice of Physical Education(4)*, Theory of Music(4), Practice of Music(4)*, Theory of Fine Arts(4), Practice of Fine Arts(4)*
	Foreign Language \	English(8)	German I(6), French I(6), Spanish I(6), Chinese I(6), Japanese I(6), Russian I(6), Arabic I(6)	English I(8), English II(8), English Conversation(8), English Comprehension(8), English Composition(8) German II(6), French II(6), Spanish II(6), Chinese II(6), Japanese II(6), Russian II(6), Arabic II(6)

	Chinese Characters Disciplines Culture		Chinese Characters(6) Disciplines(6) Philosophy(4), Logics(4), Psychology(4), Education(4), Life Economics(4), Religion(4), Life & Environment(4), Business(4), Others(4)	Chinese Characters & The Classics(6)
	Completion Unit	(56)	over 24	below 112
Discretional Activity		(12)		
Extracurricular Activity		(4)	8	
Grand Total of Completion Units			216	
* The numbers in ( ) mean total instructional hours per week during one semester counted as 17 weeks. * One instructional hour covers 50 minutes. * The standard number of school weeks is 34 a year.				

5. Synopsis of the Current Mathematics Curriculum

The current mathematics curriculum is organized and implemented in a 'level based differentiated curriculum' manner in the ‘Compulsory Period’(from grade 1 to 10; 10 levels and each level with 2 sub-levels A and B). On the other hand, in the ‘Elective Period'(from grade 11 to 12; 2 levels and each level with 2 sub-levels A and B), 'subject selection differentiated curriculum' manner is applied for the students to select their own subjects based on their needs and capacities.

A. 'Compulsory Period'

The ‘Compulsory Period’ mathematics curriculum consists of the following six content domains: 'Numbers and Operations', 'Geometric Figures', 'Measuring', 'Probability and Statistics', 'Letters and Expressions', and 'Patterns and Functions'. In the domain of 'Numbers and Operations', students can understand the concepts of natural numbers, integers, rational numbers, and real numbers. Also, they can correctly add, subtract, multiply, and divide those numbers. In the domain of 'Geometric Figures', students can understand the concepts and the nature of plane figures and solid figures. In the domain of 'Measuring', students can understand and apply the concepts of length, time, weight, angle, width, volume, and trigonometric rate. In the domain of 'Probability and Statistics', students can understand the concepts of the numbers of cases, probability, and can organize and represent data in tables and graphs. In the domain of 'Letters and Expressions', students can use the letters in representing mathematical ideas to solving expressions and understanding the concepts of equations and inequalities. In the area of 'Patterns and Functions', students can explore patterns and understand the basic concepts of correspondence, linear functions, quadratic functions, rational functions, irrational functions and trigonometric functions, and can use problem-solving strategies.

(1) 'Number and Operation' Domain

As we can find easily in following table, the quantity of the contents of 'Number and Operation' domain begins to steeply decrease at grade 8. This 'Number and Operation' domain has been separated into two domains such as 'Number' and 'Operation' up to the 6th curriculum. Considering the fact that these two domains have traditionally contained main contents in elementary school mathematics, it is natural that this domain has become an abnormally large domain that is a prime consideration for teachers.

In the aspect of a shift in contents occurred in those mathematics curriculums including the present curriculum, the content "set" is regarded as the most dynamically changed one. Thus we do not hesitate to mention sets as a representative content in discussing the changes in school mathematics curriculum in Korea. In the third curriculum initiated in 1973, sets first appeared in grade 2. After that first appearance, however, sets were continuously moved to upper grades following changes in the curriculum changes. After all, in the current (the 7th) curriculum sets disappeared in elementary school mathematics, and appears first in the 7th grade.

(2) 'Geometric Figure' Domain

The 'Geometric Figure' domain, which traditionally has been a solid one, now undergoes big changes in the current curriculum. The first remarkable change is that 'spatial perception' is newly introduced and emphasized especially in the elementary level. The content 'spatial perception' was prescribed by the NCTM(1989) in *Curriculum and Evaluation Standards for School Mathematics* as a subject that should be included in the mathematics curriculum at

[Table 5] Contents of the 'Number and Operation' Domain

Grade		Contents
1	A	whole numbers up to 50/ adding and subtracting simple numbers/ applying addition and subtraction /
	B	whole numbers up to 100 / applying various ways of number counting / adding and subtracting 1-digit whole numbers / adding and subtracting 2-digit whole numbers / applying addition and subtraction
2	A	whole numbers up to 1000 / adding and subtracting 2-digit whole numbers / introducing of multiplication / applying addition and subtraction
	B	multiplication table / adding and subtracting in the range of 3-digit whole numbers / using addition, subtraction, and multiplication
3	A	whole numbers up to 10000 / adding and subtracting 3-digit whole numbers / introducing division / multiplication and division / applying multiplication and division / understanding fractions
	B	adding and subtracting 4-digit whole numbers / multiplication and division / unit fraction and proper fractions / understanding decimal fractions(down to a 10^{th})
4	A	whole numbers greater than 10000 / four kinds of operation of natural numbers / various fractions / adding and subtracting fractions with an equivalent denominator
	B	fractions / decimals / comparing the order of fractions and decimals / adding and subtracting decimals
5	A	divisors and multipliers / reducing a fraction to its lowest terms and then to a common denominator / adding and subtracting fractions with different denominators / multiplying fractions
	B	multiplying and dividing fractions and decimals
6	A	Decimals and fractions
	B	Dividing fractions and decimals
7	A	set / properties of natural number / decimal system and binary system / integer and rational number
8	A	Rational number and decimal
9	A	Square root and real number / computing expressions
10	A	law of set operation and statement / real number / complex number

the elementary and middle school levels. Also, the importance was continuously emphasized in *Principles and Standards for School Mathematics*(NCTM 2000). Similarly, in our mathematics curriculum, almost every step from grade 1 to 6 contains 'spatial perception' as an important content. This 'spatial perception' content mainly consists of space movement related contents, so called a 'motion geometry', which could be instructed through the learners' own positive learning activities dealing with concretely contrived geometric devices, so that they would contain purposed geometric concepts. Instruction of 'spatial perception' is expended such an order as: experiencing the various spatial senses; operating spatial senses mentally; and utilizing and expressing the spatial sense mathematically.

The second notable change is actually not about content itself but about 'something noteworthy in instructing' which was described in the curriculum document. So to speak, in dealing with proposition proof, this curriculum urges not straight proof but referring to intuitions or to considering related problematic situations.

[Table 6] Contents of the 'Geometric Figure' Domain

Grade		Contents
1	A	shapes of solid figures
	B	shapes of plane figures / spatial perception
2	A	simple plane figures / spatial perception
	B	constructing solid figures
3	A	angles and plane figures / spatial perceptions
	B	components of circles / spatial perceptions
4	A	angles and various triangles / size of an internal angle
	B	various quadrangles / spatial sense
5	A	properties of right hexahedron and regular hexahedron / spatial perceptions
	B	congruence and symmetry
6	A	properties of prisms and pyramids / spatial perceptions
	B	various solid figures
7	B	basic geometric figures / construction and congruence of figures / properties of plane figures / properties of solid figures
8	B	properties of triangle and rectangle / similarity of geometric figure / application of similarity
9	B	Pythagorean theorem / circle and straight line / angle at the circumference
10	B	coordinate in the plane / equation of straight line / equation of circle / displacement of figures

(3) 'Measuring' Domain

Strongly interrelated domain with 'Geometric Figure' is the domain 'Measuring'. For instance, even though both domains deal with the common geometric figures 'Geometric Figure' domain handles the constituent elements and the properties of the geometric figures. On the other hand, 'Measuring' domain talks about the length, area, and volume of the geometric figures.

[Table 7] Contents of the 'Measuring' Domain

Grade		Contents
1	A	comparing various quantities
	B	reading time
2	A	length / clock and time
	B	length / estimating measures
3	A	length / time
	B	Capacity
4	A	time / degree of angle / weight
	B	Estimation
5	A	length of circumference of plane figure / area
	B	various units / area of various figure
6	A	surface area and volume / measurement values
	B	the circular constant and the area of a circle / the surface area of a cylinder and the volume of a cylinder
7	B	polygon and measure of angle / length, area, volume of geometric figures
8	B	approximate value and errors / adding and subtracting
9	B	trigonometric ratios
10	B	region of inequalities

(4) 'Probability and Statistics' Domain

In the 7th mathematics curriculum, stem-and-leaf plots have been introduced for the first time. Stem-and-leaf plots provide efficient ways of showing information, as well as comparing different sets of data. Moreover, they are very easy and interesting for the elementary students to learn.

[Table 8] Contents of the 'Probability and Statistics' Domain

Grade		Contents
1	B	Arranging
2	B	Ccomposing tables
3	B	Organizing data
4	B	Broken line graphs / expression of various graphs
5	B	Representing data
6	A	Proportional graph
	B	The number of outcomes in an event and probability
7	B	Distribution and its graph / relative frequency/ distribution and cumulative frequency
8	B	Basic properties of probability
9	B	Scatter gram
10	B	Standard deviation

(5) 'Letters and Expressions' Domain

In the 'Letters and Expressions' domain the main features of the contents are separated into two parts according to the school level. One is the 'problem solving' which runs throughout the elementary school level(grade 1 through 6), and the other one is the 'equation and inequalities' which runs throughout the middle and high school level(grade 7 through 10). In fact, in the elementary school level, the concept of real mathematical 'letters' or 'expressions' are not proper to learn and the 'problem solving' could not either be properly included in the domain. Thus, the content 'problem solving' was included in the domain just for convenience' sake. Considering the fact that problem solving could not be treated as simply a mathematical content but as a way to teach and learn mathematics, it is not a proper way to locate the 'problem solving' in the middle of the curriculum as if it would be one of the normal mathematics contents.

(6) 'Patterns and Functions' Domain

Finding patterns in mathematics is a powerful problem-solving strategy. This pattern was newly systemized into the current school mathematics curriculum. Instructions of patterns in this curriculum is categorized into three topics such as : experiencing various patterns and finding rules; representing and creating patterns; and expressing patterns into mathematical rules and making use of them.

[Table 9] Contents of the 'Letters and Expressions' Domain

Grade		Contents
1	B	expressions using □ / problem-solving strategies
2	A	searching for the value □ / problem posing
	B	composing expressions / solving equations / problem-solving strategies
3	B	problem-solving strategies
4	A	method of problem solving
	B	problem-solving strategies
5	A	problem-solving strategies
	B	problem-solving strategies
6	A	problem-solving strategies
	B	problem-solving strategies
7	A	using letters and calculating expressions / equation / applying linear equations
8	A	computation of expressions / simultaneous equations with two unknown / application of simultaneous linear equations / linear inequalities and simultaneous linear equations / application of linear inequalities and simultaneous inequalities
9	A	multiplication of polynomials and factorization / quadratic equation / application of quadratic equation
10	A	polynomials and their operation / factorization, divisors and multiples of polynomials / rational and irrational expression / equation and inequalities

Up to the 6th curriculum the function was defined in such manner as not the dependence of quantities, but the fact of the correspondence itself, on the basis of which certain objects are regarded as being assigned to other certain objects. The concept of a function is reduced to set-theoretical definitions. However, in this curriculum the function is explained as a variable quantity that is dependent upon another variable quantity. Thus the essence of the concept is the dependence of quantity.

B. 'Elective Period'

In mathematics curriculum, this 'selective' curriculum manner is applied to all the students in grades 11 and 12. In these two grades various mathematics subjects are available such as 'Practical Mathematics,' 'Mathematics I,' 'Mathematics II,' 'Calculus,' 'Probability and Statistics,' and 'Discrete Mathematics'.

[Table 10] Contents of the 'Patterns and Functions' Domain

Grade		Contents
1	A	Searching for patterns
	B	Searching for patterns
2	A	Searching for patterns
	B	Searching for patterns
3	B	searching for patterns
4	A	finding patterns
	B	rules and functions
5	A	constructing regular figures
6	A	ratio and rate / proportional expression
	B	patterns and correspondence / continued ratio and proportional distribution
7	A	function and its graph / application of function
8	A	linear functions and graph / application of linear function
9	A	Quadratic function and its graph
10	B	functions and their applications / rational functions and irrational functions / trigonometric functions and their graphs / application of trigonometric function

(1) Practical Mathematics

'Practical Mathematics' is an optional course offered to students who want to learn mathematics for daily life without having to complete the 10th level. This subject enables students to apply the basic concepts and rules of mathematics, to consider various types of problem solving in real life situations. The contents emphasize the application of mathematics in the four domains: the calculator and the computer, economic life, everyday statistics, and problem solving. The contents use easy and interesting material from real life which are based on the mathematics lower than the 10th level.

(2) Mathematics I

'Mathematics I' is the first course to be offered to students who wish to study advanced mathematics after completing level 10 of 'Mathematics' in the Compulsory Period. Through this course, students understand basic mathematical concepts, principles, and laws, and develop mathematical thinking ability, logical reasoning ability, and reasonable and creative problem-solving ability. This course is a prerequisite for 'Mathematics II'.

[Table 11] Contents of 'Practical Mathematics'

Domain	Contents	
calculator and computer	Calculator	functions of the calculator / use of the calculator
	Computer	functions of the computer / simple programming / use of computer software
economic living	Banking	Interests / saving installment and loan installment
	insurance	Medical insurance / car insurance
everyday statistics	arrangement and summary of a set of data	various graphs and tables / mean and variance
	application of probability and statistics	concepts and application of probability / expected value / application of binomial distribution / poll
Problem solving	optimization	linear programming / optimization
	problem solving	problem solving in daily life / problem solving through the computer

[Table 12] Contents of 'Mathematics I'

Domain	Contents	
Algebra	exponent and logarithm	exponents / logarithms
	Matrix	matrices and operations on matrices / systems of linear equations and matrices
	Sequence	arithmetic sequences and geometric sequences / various sequences / mathematical induction / algorithms and flowcharts
Analysis	limit of sequence	limits of infinite sequences / infinite series
	exponential function	exponential functions and their graphs / exponential equations and their inequalities
	logarithmic function	logarithmic functions and their graphs / logarithmic equations and their inequalities
Probability and Statistics	permutation and combination	number of cases / permutations / combinations / binomial theorem
	Probability	meaning of probability / computations in probabilities
	Statistics	probability distribution / statistical estimation

The contents consist of an 'algebra' domain, including exponents and logarithms, matrixes and sequences; and 'analysis' domain, including the limits of sequences, exponential functions, logarithmic functions; and a 'probability and statistics' domain, including permutation and combination, probability, and statistics.

(3) Mathematics II

'Mathematics II' is a course to be offered to the students who want to study more advanced mathematics after 'Mathematics I'. Through this course students can attain deeper mathematical knowledge and better develop their mathematical thinking ability, logical reasoning ability, and then develop abilities and attitudes to solve problems reasonably. This course is suitable for students who wish to study the natural sciences or technological sciences at the college level.

The contents of 'Mathematics II' consist of an algebra domain, including equations and inequalities; an analysis domain, including limits and the continuity of a function, the differentiation and integration of polynomial functions; and a geometry domain, including quadratic curves, space figures and coordinates of space.

[Table 12] Contents of 'Mathematics II'

Domain	Contents	
algebra	Equations	Fractional equations / irrational equations
	Inequalities	cubic and biquadratic inequalities / fractional inequalities
analysis	the limit and continuity of a function	limits of a function / continuity of a function
	The differentiation of a polynomial function	differential coefficients / derivatives / applications of derivatives
	the integration of a polynomial function	indefinite integrals / definite integrals / applications of definite integrals
geometry	quadratic curves	parabola / ellipse / hyperbola
	space figures	a line and a plane in space / parallels and perpendiculars / orthogonal projections
	coordinates in space	coordinates of a point / distance between two points / internal division point and external division point / equation of a sphere
	Vectors	operations of vectors / inner products of vectors / equations of a line and a plane

(4) Differentiation and Integration

'Differentiation and Integration' is a course designed for students who want to study advanced differentiation and integration of various functions after having completed 'Mathematics II'. In this course students will be able to gain advanced knowledge in differentiation and integration. They will develop their mathematical thinking, logical reasoning, and problem-solving ability. This course is appropriate for students who want to study the natural sciences or technology at the college level.

The contents consist of trigonometry, the limits of trigonometry, the limits of exponential functions and logarithmic functions, differentiation and integration of various functions, and the application of differentiation and integration.

[Table 13] Contents of 'Differentiation and Integration'

Domain	Content	
analysis	trigonometric functions	The addition theorem of a trigonometric functions / trigonometric equations
	the limits of a function	The limit of trigonometric functions / the limit of exponential and logarithmic functions
	differentiation	The differentiation of various functions / the application of differentiation
	integration	indefinite integrals / definite integrals / applying definite integrals

(5) Probability and Statistics

'Probability and Statistics' is an optional course offered to students who wish to study applied probability and statistics without having to have completed level 10 mathematics. This subject enables students to improve their data processing ability and their inferential ability necessary for the information age. It will enable them to understand the statistical phenomena in society and nature and, hence, to improve their analytical ability. It is suitable for students who need to use probability and statistics in real life situations through experimental and operational activities.

The contents consist of real life examples in the following four areas: descriptive statistics, probability, random variables, probability distributions, and statistical estimation, all of which are based on the first 10 levels.

[Table 14] Contents of ‘Probability and Statistics’

Domain	Content	
descriptive statistics	Arrangement of a set of data	frequency tables and histograms / stems and leaf graph
	Summary of a set of data	measures of central tendency / measures of dispersoion
probability	Probability	the definition and properties of probability / counting technique
	Conditional probability	conditional probability
random variables and probability distribution	Random variable	discrete random variables / continuous random variables / expected value and variance
	Probability distribution	binomial distribution / normal distribution
statistical estimation	Sample	population and sample / sample mean and its distribution
	interval estimation	estimation of population mean / estimation of population proportion

(6) Discrete Mathematics

'Discrete Mathematics' is offered to students regardless of whether they have completed Level 10 mathematics or not. In 'Discrete mathematics', using basic mathematical concepts, principles, and laws will develop the student's abilities and aptitude to analyze mathematically, to think logically and to solve reasonably finite or discontinuous discrete problem situations. This is a course needed for students who want to have experience in discrete mathematical knowledge.

The contents consist of four domains: selections and arrangements, graphs, algorithms, and decision making and optimization. For each of these domains, various real world problems should be utilized to lead students to easy and interesting discrete mathematical situations.

IV. Directions of the Future Mathematics Curriculum in Korea

Compared to Western countries, Korea has a very short history of modern mathematics education and a short curriculum revision term as well. This supposedly could be a main reason why we had not have invested enough times and efforts in curriculum revision and construction study for a new mathematics curriculum. Thus we cannot escape from the blame that the background philosophy of the mathematics curricula usually follows those of foreign curricula,

[Table 15] Contents of 'Discrete Mathematics'

Domain	Content	
selections and arrangements	permutations and combinations	permutations / combinations
	Enumerations	arrangements / the inclusion-exclusion principle / set partitions / integer partitions / distributions of graphs
Graphs	Graphs	graph models / examples of graphs
	Trees	examples of trees / minimal spanning trees
	covering circuits	Euler circuits / Hamilton circuits
	applications	matrix models / matrices and graphs / graph coloring
algorithms	numbers and algorithms	patterns in numbers / numbers and algorithms
	recurrence relations	first-order linear recurrence relations / second-order recurrence relations
decision making and optimization	decision making procedure	2×2 games / election procedure and fairness
	optimization and algorithms	optimization in scheduling / graphs and optimization

lacking our own educational philosophy. However, nowadays one fortunate thing is that Korean students have become to show extraordinary abilities in mathematical exploration and high achievement levels in mathematics learning in international mathematics achievement competitions. This might symbolize that Korean mathematics education and the mathematics curriculum have not been so much slapdash. Finally in this chapter, reflecting the past mathematics curriculum revision processes we are going to discuss further about the future directions of the mathematics curriculum.

1. Construction of Our Own Curricular Philosophy

In Korea the main blaming that is targeted towards the policy of mathematics curriculum revision has been that our mathematics curriculum has not contained our own philosophy in terms of the mathematics curriculum and usually followed those of foreign curricula. Although western countries' philosophy of mathematics education is introduced so well in Korea that does not mean that it can be directly imported as our own philosophy of mathematics education (Park

2003). For example, in Korea attempts are being made to introduce the social process of creating knowledge into mathematics classes. Class activities using cooperative small group learning are also being encouraged in an effort to let more students participate in discussion and the social negotiation process. The widely-discussed method of small group cooperative learning doesn't seem to sit well with Korean students. This is because they are traditionally taught not to doubt the teachings of their ancestors or the great men of past generations, let alone argue against it. However, students of the West have been trained at an earlier age to actively engage in and take advantage of small group cooperative learning. In contrast, small group activities do not make much sense to students in Korea, as they have never received this type of training. This could be a typical example that demonstrates the fact that western philosophy cannot be immediately transplanted to Korea.

On the other hand, one interesting observation with relation to this fact is that, while the East makes efforts to follow its Western counterpart, the West makes endeavors to take after the East. For example, educational experts in the U.S. are very much interested in Singapore's mathematics textbooks and have tried to discover what is securing Singapore in a top position in the TIMSS(Third International Mathematics and Science Study) and TIMSS-R in the category of mathematics textbook. Otherwise, Western scholars are amazed about how Japanese mathematics textbooks are so small and thin and yet display core ideas so economically. In such ways, both the East and the West are benchmarking each other in the mathematics education field. That is, we need to strive to find out what is the most optimal philosophy of mathematics education, that incorporates our own way of thinking and circumstances rather than indiscreetly following the western mathematics education.

2. Optimization of Mathematics Contents

One of the main objectives of a curriculum revision is to determine the appropriate amount and the level of depth and difficulty of educational contents. Since the 4th curriculum, curricula have been revised under the basic principle of reduction of the amount and lowering the difficulty level in order to accomplish the optimum amount and difficulty of educational contents. Furthermore, the 7th curriculum policy specifically instructed 30% reduction, which the mathematics curriculum was unable to fully comply with. Accordingly, the next mathematics curriculum revision should be more proactive in reducing the amount and lowering the level of difficulty of mathematics contents. At the same time, the topics to be omitted should be determined based on more comprehensive perspective and systematic consideration rather than considering simply educational conveniences.

However, in pursuit of the optimization of educational contents, we are bound to encounter some kind of educational dilemma (Park 2003). That is, how can an optimal level of school mathematics be decided? By how much should we reduce the amount and to what extent should we lower the level of difficulty? Even if we agree with the fact that the majority of students find mathematics difficult and we reduce the amount and lower the difficulty level, there will likely still be complaints that mathematics requires much work and is difficult. This is because of the abstract and deductive nature of mathematics. We cannot lower the level of difficulty too significantly because we have to consider mathematically superior students as well. In order to satisfy two different types of students, we must move away from inflexible practices such as imposing the same amount and level of difficulty of mathematics to the entire group of students.

Therefore, instead of indiscreetly reducing the amount and lowering the level of difficulty, it is recommended to divide the contents into two core contents and optional contents. In fact, the 7th curriculum attempts to divide the contents into a core section and an optional one, and these are explicitly stated in the curriculum document. However, optional contents tend to function as core contents for all the students because in Korea, the topics in curriculum are considered as a minimum essential. Hence, it is necessary for the next revised curriculum to clearly mention that optional contents are for mathematically superior students and strictly differentiate optional contents from core contents(Park 2003).

3. Complement of the Differentiated Curriculum

Ever since the introduction of the differentiated curriculum in the 7th curriculum, the drawbacks of implementing the differentiated curricula providing differentiated educational contents depending on the different levels of students have long been confidentially talked about. However, judging from the current tendency of educational philosophy, such a differentiated curriculum system is likely to be continued to the next curriculum revision along other complementary measures.

According to Park(2003), the idea of adopting differentiated curricula for different levels of students has been criticized for not adhering to the East Asian tradition portrayed in Collective We-ness. The East Asian culture believes in orthodoxy, and students are expected to adhere to a uniform curriculum despite their individual differences. In the Western culture however, the individual is of paramount importance. Hence the curriculum must be adjusted to the needs of the individual rather than the individual adjusting to an orthodox curriculum(Leung 2001; Park & Leung 2002).

Nevertheless, if the differentiated curriculum that is first applied in the 7th curriculum with much expectation ends with no tangible results and does not continue later, it may cause even more confusion(Park 2003). Therefore, it seems to be reasonable to maintain the differentiated curriculum by complementing the drawbacks of the curriculum in the next curriculum and attempt to gradually stabilize it.

4. What and How to Teach Mathematics in the Next Curriculum

Prospective students must be provided with experiences that will cause them to become active, flexible thinkers and users of mathematics. It is critical that all students regardless of ability be involved in and see themselves reflected in the mathematics curriculum. It is essential that possibly all students are engaged in a program that contains appropriate mathematical content and learn the content to form a knowledge base. The program must be one which can be expanded in the future to broaden their career and economic horizons and allow the students to adapt with the changing times.

The primary focus of the mathematics curriculum is to help students become good problem solvers. Learning experiences must cycle between using problems to motivate knowledge base development and using the knowledge base to solve problems. To accomplish this, problem solving should include the processing of information, thinking analytically, coping with changes, and making decisions by using mathematics with varying degrees of sophistication. Classroom instruction should provide for a natural learning sequence with allows for the transition from concrete to semi-concrete to semi-abstract to abstract learning experiences.

The instructional climate must allow students to communicate their mathematical ideas freely and to turn mathematical errors into positive learning experiences. Discussions should occur using the language of mathematics to verbalize the processes used to develop concepts and solve problems. Experiences should be designed to allow students to interact with each other and the teacher while attaining a knowledge base and solving problems.

Since students comprehend mathematics through various learning strategies, a variety of evaluation techniques must be employed. Evaluation of the students' knowledge base and problem-solving ability must not be limited to only paper-and-pencil testing.

More minutely saying, future mathematics curriculum should be able to guide mathematics education to the following goals. Students will be provided experiences which: (1) emphasize problem solving and thinking skills; (2) give a broad perspective to the mathematics content structure, and the interrelationships among the various structural branches; (3) consider different learning styles by using a variety of instructional strategies and materials; (4) emphasize a participatory role for learning by using mathematical language, oral discussion, writing, listening skills, and observing skills; (5) create mutual respect and equal treatment regardless of ability; (6) expand career and economic horizons; (7) incorporate technology as a thinking and learning tool; (8) assess performance through a variety of evaluation techniques.

V. Closing Remarks

School mathematics is for life and is a part of life. A high quality mathematics program guides students to experience mathematics rather than observe it. To realize such a program purpose, mathematics curriculum has to be designed to make students be actively engaged in their learning, and finally to be provided with fully understanding of mathematics. Such kind of mathematics curriculum provides students with experiences that will cause them to become active, flexible thinkers and users of mathematics. Throughout this paper we have tried to strongly suggest that for any kind of future school mathematics curriculum to works in Korea such philosophy has to be considered.

In this paper, focusing on the introduction of the 7th mathematics curriculum, we have tried to show the overall shapes and general characteristics of the Korean mathematics curriculum. We hope that the descriptions contained in this paper can provide some information to help the understanding of the Korean mathematics curriculum along with Korean mathematics education.

References

Kang, O. K. et. al(1997). *The 7th elementary and secondary school mathematics curriculum of republic of Korea.* The Ministry of Education.

Leung, F. K. S.(2001). In search of an East Asian identity in mathematics education. *Educational Studies in Mathematics, 47,* 35-51.

National Council of Teachers of Mathematics(1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA.: The Author.

National Council of Teachers of Mathematics(2000). *Principles and standards for school mathematics*. Reston, VA.: The Auther.

Minister of Education(1997). *The 7th mathematics curriculum*. Dae-Han Textbook Publishing Company, Seoul.

Park, K. M.(1998). Mathematics curriculum in Korea.

Park, K. M. & Leung, K. F. S.(2002). A comparative study of the mathematics textbooks of China, England, Hong Kong, Japan, Korea, and the United States. Paper presented at the ICMI comparative study conference, the University of Hong Kong, 20th, 25th October, 2002.

Park, K. M.(2003). Issues related to the mathematics curriculum revision. Paper presented at the Mathlove Seminar on mathematics curriculum, Seoul, 14th June, 2003.

Zhang, D.(2002). An overview of the mathematics curricula in the West and East: Summary of findings at the Chongqing conference in 2002. Paper presented at the ICMI comparative study conference, the University of Hong Kong, 20th, 25th October, 2002.