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COMPARATIVE STUDY OF SECONDARY SCHOOL MATHEMATICS PROGRAMS OF THE SELECTED MATHEMATICS STUDY GROUPS IN THE UNITED STATES WITH THE MATHEMATICS PROGRAM OF THE MINISTRY OF EDUCATION IN THE REPUBLIC OF KOREA

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Introduction

Korea, although one of the oldest nations of the Far East, is one of the least known due to a policy of isolationism that dominated the nation for almost three centuries following several devastating invasions ending in 1672. This leads to thinking of Korea as "the hermit kingdom." In 1883 the United States became the first nation to conclude a treaty with Korea.[1]

The new educational system which was established in 1945, the year of the liberation from Japanese occupation, was first administered by Americans with Koreans as observers. The Korean conflict (1950—1953) multiplied problems in education as well as in other national interests.[2] However, the progress of Korean education has continued in this decade through the enthusiasm of her people for education, through the devoted efforts of governments, and through the contributions of various foreign agencies. In particular, the United States has been one country that has rendered immediate and effective assistance to the rehabilitation of educational development since the Koreacn onflict. With an increased influence of Am erican educational practices on Korean educational programs, the Ministry of Education in Korea has allowed qualified students to study abroad in Am erica as well as in other more advanced nations.[3]

It is appropriate that a study on the given topic be made by this writer, since she has been exposed to both Korean and U.S. mathematics education through university study and through secondary school teaching.

The study was designed to compare the secondary mathematics programs of the selected mathematics study groups in the U.S. with the program of

1) Hakwon Sa, *Korea: Its Land, People, and Culture of All Ages*, Seoul, Korea: Hakwon Sa Ltd., 1960, pp.362-64.
2) Clara H.Koenig, *The Republic of Korea*, World Education Series Placement Recommendations by the Council of Evaluation of Foreign Student Credentials, Meeting of May 15-16, 1957.
3) Mungyobu, *Annual Survey of Education*, Seoul, Korea; The Ministry of Education 1965, p.13.
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the Ministry of Education in the Republic of Korea (R.O.K.) for academically oriented students. The major purpose of this study was to investigate the differences and the similarities of the programs.

The study will constitute one of useful and helpful materials in the areas of: (a) teaching secondary mathematics program and (b) works involved in research and analysis of secondary mathematics programs. The study will provide information and valuable materials to those who may wish to know more about the secondary mathematics program of the R.O.K. in relation to those of the U.S. mathematics study groups. To the writer's knowledge, there has been no comparative study published in English or in Korean on the secondary mathematics programs between the U.S. and the R.O.K. This study may be the first comparative study on mathematics programs between the two nations. The sources employed for this comparative study should be helpful to the further comparative study in other educational fields.

The Problem

The problem questions were investigated in the following sequence.

1. What is the general nature of the cultures and of secondary education in the U.S. and in the R.O.K.?
2. What can be predicted for the nature of secondary mathematics programs in the two nations stemming from the study of cultures and secondary education?
3. What is the secondary school mathematics program of selected mathematics studygroups in the U.S. for academically oriented students?
4. What is the secondary school mathematics program of the Ministry of Education in the R. O.K. for academically oriented students?
5. What are the differences and similarities of the secondary mathematics programs between the selected groups in the U.S. and the Ministry of Education in the R.O.K.?
6. What do the assessments on these programs suggest for determining changes in secondary mathematics programs for academically oriented students in the R.O.K. and in the U.S.?

Procedure

The general method employed was descriptive and comparative research. Sources for the study derived from: (1) educational documents issued by American and Korean governments, (2) publications by the U.S. study groups and by the Ministry of Education, (3) correspondences with the organizations related to the study, (4) literature reporting activities of the study groups, (5) doctoral dissertations, and (6) others.

Research and literature related to comparative study were reviewed. The general nature of the two cultures and secondary education of the two nations were discussed. The mathematics programs of the selected study groups in the U.S. were described. The selected groups included the School Mathematics Study Group (SMSG), the University of Illinois Committee on School Mathematics (UI CSM), and the Greater Cleveland Mathematics Program (GCMP). The secondary mathematics program prescribed by the Ministry of Education in the R.O.K. was described. The dlfferences and similarities of these programs were presented. Research and literature assessing the mathematics programs of the study groups and of the R.O.K. were reviewed.

Findings

1. General Nature of Culture and Secondary Education

The U.S. has the world's most advanced technological society and the highest standard of living in the world. But more important' as we have said, is that she has tried to give every American freedom

and equality of opportunity.

The U.S. has long been known as a great melting pot. Her people are of all races and have come from many different countries, but they have developed a common culture. There are many more similarities than differences among the people of the U.S.

For one thing, Americans believe that every person should have an opportunity to receive the best possible education to develop his talents and abilities.

Korea is a peninsula that extends into the Sea of Japan. The peninsula covers an area a little bit larger than Utah, but she has about 45 times as many people. After the Korean conflict ended in 1953, the peninsula was divided into two countries: in the South, the Republic of Korea, and in the North, the Korean People's Republic.

Korea has long been known as the "Eastern Land of Civility." Buddhism and Confucianism were developed in Korea, and the development of the religious or philosophical ways of life contributed much to the fostering of the native sense of activity.

Korea had been under autocratic kingdoms and autoritarian aristocracy for thousands of years before 1945. The government of the Republic of Korea has adopted the fundamental principles of democracy and a democratic educational system from the U.S.

The educational system of the U.S. has two outstanding characteristics: (1) availability of primary and secondary education to almost all children and (2) decentralization. In the U.S. the present trend in public education is for local communities to provide tax-supported and public-directed schooling for all from the age of 5 through 20.

In the R.O.K., schooling is compulsory for children only from ages 6 through 11. In secondary schools run by voluntary educational agencies, fees are charged.

The system of free public schools in each state of the U.S. is headed by a department of the State Government, commonly called the State Department of Education. Many of the states prepare courses of study for their secondary schools. The course of study is regarded as suggestive rather than prescriptive; considerable latitude is allowed to both school and teacher.

Secondary schools are primarily under supervision of the education committee of the special city, or of the provincial government and subsequently of the Ministry of Education in the R.O.K.

Secondary education in the U.S. may be either a 4-year or a 6-year program. Most high schools are comprehensive high schools.

Secondary education in the R.O.K. is a 6-year period (3 years of middle school and 3 years of high school). Secondary schools are divided into three types: (1) middle and high schools, (2) technical and higher technical schools, and (3) highercivic schools. An entry to the high school is highly selective, with an entrance examination given for admission.

General secondary schools in the U.S. are schools of the multi-track type, offering several different curricula, usually college preparatory, vocational, and business education.

2. Predictions for Nature of Mathematics Programs in the Two Nations Stemming From the Study of Cultures and Secondary Education.

The fields of technology and of science have been much emphasized in the U.S. For this reason there will be more concern over the subject of mathematics in the U.S. secondary school curriculum than in the R.O.K. curriculum.

Unlike the highly centralized system of the R.O.K., education in the U.S. has been largely a local responsibility. Thus, no prediction may be

made for any unformity among educational programs or among mathematics programs in the U.S.

Since the comprehensive high schools in the U.S. are schools of the multi-lateral type, the students will be able to choose courses in mathematics as well as in other subjects depending on their needs and abilities. Academically oriented students will be able to reap the benefits of more advanced mathematics courses. Courses in mathematics will be prepared for students at different levels with corresponding levels of content in subject matter.

There will not be enough flexibility of choice in the subject of mathematics to allow for different abilities among students in the R.O.K., unless the Ministry of Education provides for different materials with different courses of study and different textbooks for students with varying levels of ability.

The entrance examinations required for high school and for college will have a great effect on the nature of mathematics programs of the middle school in the R.O.K.

3. The Secondary Mathematics Programs of the Selected Study Groups in the U.S.

a. Objectives

The primary objective of the SMSG is to foster research and development in the teaching of school mathematics. The work of the SMSG consists primarily in developing courses, teaching materials, and teaching methods.

The objective of the UICSM is to reorganize the traditional content in the light of important concepts in contemporary mathematics. In addition to the traditional skills, the UICSM wants to emphasize that mathematics is a dynamic, intrinsically interesting discipline in which the student can exercise ingenuity and creativity.

The objective of the GCMP is to develop a comprehensive. sequential mathematics program for students, which is both mathematically correct and pedagogically sound. The basic objective of the GCMP is to prepare all students for a productive and enriched adulthood in a complex and ever-changing society.

b. The Secondary Mathematics Programs

SMSG. The structure of mathematics is emphasized in the SMSG material. The SMSG courses are characterized by the treatment of relatively conventional topics rather than by the introduction of new topics. Although students manipulate numbers, the prime objective is to develop awareness of the basic properties of mathematics. Students are encouraged to move to progressively higher Levels of abstraction.

The Mathematics for Junior High School, Volumes I and II for grades 7 and 8, are designed to preview the algebra and geometry courses of grades 9 and 10. These texts emphasize the the structure of arithmetic from an algebraic viewpoint. The materials reveal elements of the entire junior high school sequence: abstract concepts, the role of definition, the development of precise vocabulary and thought, experimentation, and mathematical truth. The First Course in Algebra for the ninth grade emphasizes the structure of algebra and is organized and motivated by fundamental structure considerations.

Geometry for the tenth grade includes plane geometry, some solid geometry, and an introduction to analytic geometry. It introduces solid geometry early to develop the student's space perception. This course connects with algebra whenever possible.

Intermediate Mathematics for eleventh grade includes trigonometry, vectors, logarithms, mathematical induction, and complex numbers. Attention has been paid to giving the student some insight into the nature of mathematical thought and to preparing him to perform manipulations with facility. Elementary Functions for the first half of twelfth grade includes the study of functions:

polynomial, exponential, logarithmic, and trigonometric, with an emphasis on practical applications. The Introduction to Matrix Algebra for the second half of twelfth grade studies focuses on matrices including applications to solutions for systems of linear equation and geometry. Structure is developed in this course. Calculus I, II, and III, and Algorithms, Computations and Mathematis are other courses offered for twelfth grade. Calculus I and II are designed for a one year courses and these are prepared for students who have completed the equivalent of eleventh grade Intermediate Mathematics. Algorithms, Computations and Mathematics is concerned with mathematical concepts which are fundamental to computer science.

UICSM. The UICSM set out to present mathematics as a consistent. unified discipline, to lead students to discover principles for themselves, and to assure the development of the manipulative skills necessary for problem solving. The UICSM emphasizes "learning by discovery," with the student working out mathematics rather than being told about it.

The four-year sequential program has been developed through eleven units: (1) the arithmetic of real number, (2) generalizations and algebraic manipulations, (3) equations and inequations. (4) ordered pairs and graphs, (5) relations and functions, (6) geometry, (7) mathematical induction, (8) sequences, (9) exponential and logarithmic functions, (10) circular functions and trigonometry, and (11)polynomial functions and complex numbers. Units 1, 2, 3, and 4 are prepared for ninth grade; units 5 and 6 for the tenth; units 7 and 8 for the eleventh; and units 9, 10, and 11, for the twelfth grade.

Considerations for the UICSM courses are (1) that the language in both textbook and teacher's guide is used with as little ambiguity as possible and (2) that discovery of generalizations by the student is encouraged and fostered.

GCMP. The GCMP materials have been written for students of varying abilities. Learning opportunities are organized in a spiraling sequential fashion; topics continually reappear, gradually increasing in complexity.

The GCMP has a pre-algebra, an academic geometry, and two developing programs. The Pre-Algebra is the course for grades 7, 8, or 9. It consists of four major series: review of fundamentals, extension and maintenance of computation, new concepts, and enrichment. The Geometry for grades 9, 10, or 11 includes four booklets: the postulational methods, basic geometry of the plane and of space, Euclidean geometry, and non-Euclidean geometry.

4. The Secondary Mathematics Program of the Ministry of Education in the R.O.K.

a. Objectives

The stated objectives of the secondary mathematics program of the Ministry of Education are summarized:

1. To develop an understanding of the fundamental concepts, principles, and laws of mathematics.
2. To develop the right habits of looking at problems mathematically and to develop an ability to solve problems effectively.
3. To give pupils a realization of the usefulness of mathematics in social, business, technical, or scientific endeavor and to develop the habit of analyzing problems scientifically.
4. To develop student's effective ability to solve mathematical problems precisely.
5. To develop student's indpendent thinking in making appropriate decisions with mathematical logic and reasoning.

b. The Secondary Mathematics Programs

The Middle School Mathematics I, II, and III are the courses prepared by the Ministry of Education for students in grades 7, 8, and 9, respecti-

vely. There are six categories in each text. Middle School Mathematics I includes: numbers, algebraic expression, ratio and ratio relation, measurement, statistics, and geometric figures. Middle School Mathematics II includes: number, computation of equations, graph and function, measurement, statistics, and figures. Middle School Mathematics III has the categories of numbees, algebraic presentation of functions, trigonometry and measurement, statistics, and figures,

Common Mathematics for tenth grade includes a study of number, approximate value, equation and inequalities, function and graphical presentation, equation of curve, and plane geometric figure and properties.

High School Mathematics I for eleventh and twelfth grades is given for those who plan to attend college with a major in liberal arts, or for those who will attend technical school. The six main areas of study are: (1) computation of logarithms, (2) sequenence and progression, (3) probability and statistics, (4) differentiation, (5) integration, and, (6) space figures.

High School Mathematics II is the course for eleventh and twelfth grade students who are bound for university or college in the science field. This course includes eight categories of study: (1) equations and inequalities, (2) exponents and logarithms, (3) the trigonometric functions; (4) sequence and progressions, (5) probability and statistics, (6) differentiation, (7) integration, and (8) figure.

5. Comparison of the Mathematics Programs of the Study Groups in the U.S. With Those of the Ministry of Education in the R.O.K.

The objectives of the study groups in the U.S. differ somewhat from those of the Ministry of Education in the R.O.K. The study groups in the U.S. have as objectives a development of the program from the point of view of origin, motivation, and activities. On the other hand, the Ministry of Education has described its objectives as related to the behavior of its studeots.

The selected study groups have had different ways of approach to their respective objectives, but each group has held some objectives in common with the others.

In the secondary mathematics programs, introduction to algebra and geometry, consumer and/or general mathematics are the courses offered by the U.S. study groups for most students in grades seven and eight. Algebra is the course prepared for students in the ninth grade.

The middle school students in the R.O.K. from grade seven through grade nine take Middle School Mathematics Ⅰ, Ⅱ, and Ⅲ. The emphasis on mathematics content in the ninth grade is to prepare students for the high school entrance examination.

By the end of the tenth grade, academically oriented students in the programs of the U.S. study groups complete the courses of algebra and geometry.

Common Mathematics in the program of the R.O.K. for grade ten has similar patterns of content to those of Middle School Mathematics.

A two-trach mathematics program in grades eleven and twelve is common to the U.S. study groups and to the Ministry of Education.

There are various courses offered in the U.S. study groups' program for eleventh and twelfth grades: intermediate mathematics, trigonometry, solid geometry, elementary functions, matrix algebra calculus, and other higher mathematics But there are only two mathematics courses in the program of the Ministry of Education: Mathematics Ⅰ and Ⅱ.

Content comparison has been made by analyzing each study group program in the U.S. and the program of the Ministry of Education. Three cat-

egories (number system and relation, figure, and application of mathematics) have been used for the comparative study of the programs from seventh grade to tenth. The differences and similarities of the mathematics contents in the program have been analyzed for the programs of grades eleven and twelve.

6. Assessments of Mathematics Programs

Much of the research and literature on new mathematics dealt with the programs of the SMSG and the UICSM. Many of the researches compared the materials of the study groups with the traditional materials.

The major findings of the testing programs and of the researches showed that there were no significant differences in achievements between students using the SMSG materials and those using traditional materials.

It has been found that the UICSM included a great deal of material used in the discovery principle. A statistically significant difference in the understanding of basic mathematical concepts in favor of the UICSM group was obtained in the upper intelligence level of students comparing the effectiveness of the UICSM material. The UICSM had more untraditional materials than the other modern programs.

Comparison studies of the GCMP and the materials of other groups or traditional programs were not sponsored by the GCMP, and no research has yet been done by the GCMP for the evaluation of the secondary mathematics program.

There has been no research comparing the secondary mathematics programs in the R.O.K., since all secondary schools have to follow the curriculum prescribed by the Ministry of Education.

There was one survey made by the Ministry of Education to determine the degree of the student's interest in the subject of mathematics. Other activities for evaluating mathematics programs have involved the survey of mathematics teachers and their seminars.

Discussion of Findings

1. It was found that the study of the mathematics program was related directly or indirectly to some aspects of the culture and general education of a nation. 2. The programs of the U.S. study groups had more flexible and varied courses in the subject of secondary mathematics for academically oriented students than those of the Ministry of Education. 3. There was no uniform secondary mathematics program in the U.S. However, a general pattern of the mathematics program among the study groups was found to exist. 4. The U.S. groups stressed emphasis on unifying ideas in secondary mathematics. The groups attempted to direct the materials toward a precise, integrated mathematics sequence, and new topics. 5. The SMSG developed the secondary mathematics program for academically oriented students for all grades. The GCMP and UICSM developed programs for lower and upper grades of the secondary school, respectively. 6. There were more similarities between the materials of the SMSG and of the R.O.K. than between those of other groups and of the R.O.K. 7. Application of mathematics was emphasized more in the program of the R.O.K. than in the U.S. group programs. 8. The R.O.K. program had too much detail for each grade level, and not enough flexible content for the different levels of the students.

Recommendations

A review of the findings and a discussion of the findings of this study led to the following recommendations for both the U.S. study groups and the Ministry of Education in the R.O.K.

1. It is recommended that the objectives of secondary mathematics programs for academically oriented students should broaden and include more incentive to creativity, positive attitudes, learning

how to learn, and values. The computational skill and mastery of concept should remain important in the objectives of the secondary mathematics programs.

2. There is a need for secondary mathematics programs to place the proper amount of stress on developing the following: (1) understanding, accuracy, and facility in the fundamental process of computation; (2) ability to use the problem solving method in all situations; and (3) an understanding of the nature and structure of mathematics so that students can apply it.

3. It is recommended that secondary school mathematics programs should provide for a sequential presentation of general and special mathematics, contributing to the present and probable future educational, vocational, and cultural needs of students.

Recommendations for the U.S. study groups are:

1. A continuous effort must be made toward the production of improved materials of instruction for secondary school mathematics. There is no doubt that excellent materials have been produced by the SMSG, UICSM, and GCMP in the U.S.

2. Since the SMSG program is producing materials for all grades in the primary and the secondary levels, academically oriented students will be able to gain benefits from the SMSG material using the SMSG materials of both primary and secondary levels in a continuum.

3. The UICSM may be started in the upper level of the secondary school for academically oriented students. The GCMP program may be started in the lower level of the secondary school for academically oriented students. If students are exceptionally proficient in mathematics the UICSM may be used for them in grade 7 or grade 8.

4. It is recommended that continuous research and activity be directed toward the objectives of each study group for the secondary mathematics program, and that mutual cooperation and communication be cultivated among study groups for the improvement of secondary mathematics programs in the U.S.

Recommendations for the Ministry of Education in the R.O.K. are:

1. More flexible contents of courses in secondary mathematics and more varied materials, with meaningful activities needed in the program of the Ministry of Education.

2. The program should emphasize the concepts of mathematics as a part of the whole mathematics, not as asubdivision of the field, such as algebra or geometry. The mutual relationships between algebra and geometry must be provided in the material.

3. It is recommended that the mathematics program should place emphasis on:

a. A sequential mathematics program, developing the structure of mathematics that contains the basic skills and concepts of mathematics.
b. Presenting a mathematics program as a consistent and unified discipline, leading students to discover mathematics principles for themselves.
c. Correct generalizations by emphasizing logical deduction.

Recommendations for further study:

1. The results on the assessments of secondary mathematics programs of the U.S. study groups (SMSG, UICSM, and GCMP) and of the Ministry of Education in the R.O.K. were reviewed to investigate the possibilities of changes in secondary mathematics programs. However, further study in needed to answer:

a. What criteria should be used in selecting instructional materials and in evaluating these materials for academically oriented students?
b. How do we evaluate the effectiveness of a new or modern mathematics program, if the programs of the U.S. study groups are in fact considered to be modern programs?