Chapter 5
Factors Contributing to Korean Students’ High Achievement in Mathematics

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Abstract
The mathematics performance of Korean students displayed in the international comparative studies was remarkable. Six factors as reasons that made such high achievement in mathematics possible were identified: competitive examination and selection, a simple and regular number system, serious attitudes of students towards tests, Asian pragmatism and meaningful repetitive learning, competence of mathematics teachers, and the cycle of competent teachers and competent students.

I. Introduction
Recently there has been a consensus that facility with mathematics is key to success in a global economy driven by technological development and the use of information and. Hence, it is desirable phenomena for Koreans that our students have consistently performed well in recent international studies of mathematics achievement, the Third International Mathematics and Science Study (TIMSS) and its follow up study(TIMSS-R), OECD Program for International Student Assessment (PISA), and the International Mathematics Olympiad.

The merits of such international studies do not lie in constructing a league table of countries, but in identifying factors that contribute to high achievement, and in understanding the practices of other countries for the sake of improving the education in one’s own country. In this regard, it is necessary to search for what accounts for the high achievements of Korean students in mathematics.

II. Korean Students’ Mathematics Achievement in International Comparative Studies
Korean students came in at 2nd place in the fourth grade and 3rd place in the eighth grade mathematics tests in TIMSS (Beaton et al., 1996; Mullis et al., 1997), drawing wide attention of researchers on mathematics education in Korea and abroad. The TIMSS-R results (Mullis et al.,
2000) showed that Korean students maintained a high position among 38 participating countries. Analysis of the Korean data shows that the eighth grade Korean students in TIMSS-R attained even higher levels of achievement in mathematics than in TIMSS.  

<Table 1> The Results of Mathematics Performance in TIMSS and TIMSS-R

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Difference from average across countries</th>
<th>Rank</th>
<th>Country</th>
<th>Difference from average across countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Singapore</td>
<td>87 (3.8)</td>
<td>1</td>
<td>Singapore</td>
<td>80 (5.9)</td>
</tr>
<tr>
<td>2</td>
<td>Japan</td>
<td>59 (1.8)</td>
<td>2</td>
<td>Korea</td>
<td>63 (2.0)</td>
</tr>
<tr>
<td>3</td>
<td>Korea</td>
<td>59 (2.1)</td>
<td>4</td>
<td>Hong Kong</td>
<td>58 (4.2)</td>
</tr>
<tr>
<td>4</td>
<td>Hong Kong</td>
<td>47 (5.8)</td>
<td>5</td>
<td>Japan</td>
<td>55 (1.8)</td>
</tr>
</tbody>
</table>


The mathematics performance of Korean students in PISA is similar, they ranked in the 2nd place next to Japan among 32 participating countries (OECD, 2001).

<Table 2> The Results of Mathematics Performance in PISA

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Mean (S.D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Japan</td>
<td>557 (87)</td>
</tr>
<tr>
<td>2</td>
<td>Korea</td>
<td>547 (84)</td>
</tr>
<tr>
<td>3</td>
<td>New Zealand</td>
<td>537 (99)</td>
</tr>
<tr>
<td>4</td>
<td>Finland</td>
<td>536 (80)</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>500 (100)</td>
</tr>
</tbody>
</table>

1 The high achievements of Korean students do not seem to be accompanied by correspondingly positive attitudes towards mathematics. According to the results of the TIMSS-R questionnaire, Korean students ranked very low in the indexes of ‘students’ report on whether it is important to do well in mathematics’, ‘students’ positive attitudes towards mathematics’, and ‘students’ self-concept in mathematics’. However it may perhaps be wrong to accept the above student questionnaire results at face value and conclude that Korean students have a more negative attitude than their counter-parts in Western countries. In fact, the Korean culture under the influence of Confucian tradition stresses the virtue of humility or modesty and hence there may be tendency for their students to underestimate their ability. Traditional teaching in Korea(East Asia in general) requires teachers to teach students not to be conceited while imbuing a proper level of confidence and modesty into them, and sparse praise for students.
Korean students also ranked high in recent International Mathematics Olympiad. Thus, in Korea, top students as well as students in general showed outstanding performance in mathematics.

<table>
<thead>
<tr>
<th>Year</th>
<th>Rank</th>
<th>Number of participating countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>7</td>
<td>81</td>
</tr>
<tr>
<td>2000</td>
<td>4</td>
<td>81</td>
</tr>
<tr>
<td>2001</td>
<td>4</td>
<td>83</td>
</tr>
<tr>
<td>2002</td>
<td>6</td>
<td>84</td>
</tr>
<tr>
<td>2003</td>
<td>6</td>
<td>82</td>
</tr>
</tbody>
</table>

III. Factors Contributing to High Achievement in Mathematics

Various reasons have been suggested to account for the high achievements of Korean students in international comparative studies of mathematics achievement (Park & Leung, 2003). Among them, the following six factors seem to be prominent.

1. Examination and Selection

One of the major factors influencing students’ high achievement in mathematics in Korea appears to be the national enthusiasm for education, the eagerness for study, and the ethics of hard work. This is definitely the situation with Korea, where there is a strong zeal for education.

It is a well-known phenomenon that the focus of primary and secondary education in Korea is on subjects required in the national college entrance examination (known as the College Scholastic Ability Test, CSAT). The CSAT is a highly competitive examination which selects secondary school students for entrance into universities, and mathematics is one of the four areas that are assessed in CSAT. Since students are more discriminated by mathematics scores than by scores in other subjects, mathematics becomes most effective when it comes to a selection-oriented education environment, and schools tend to place a relatively high importance on the subject of mathematics.

In addition, there are many private institutions and tutoring courses dedicated to preparing students for the subjects of CSAT. Korean students and parents take education very seriously, and these private institutions and tutoring courses, in parallel with regular schooling, become
major elements of education in Korea. According to a survey administered by the Korean Institute of Educational Development (KEDI, 2003), 72.6% of the Korean students (83.1% of elementary students, 75.3% of junior high and 56.4% of senior high school students) are receiving at least one private lesson beyond school work. While private education courses cover a wide range of subjects, mathematics is the most common, and most secondary school students attend additional mathematics private institutions or receive tutoring outside school hours. This reflects Korean students’ emphasis on mathematics, and results in Korean students having more exposure to mathematics instruction and practice.

2. Number System

Two characteristics of the Korean number system may have contributed favorably to Korean students’ high level of performance in mathematics: the simple pronunciation of numbers and the regularity of the number system.

The pronunciations of Korean numbers are relatively simple. Korean numbers up to 10 are all pronounced in one syllable, making it rather efficient for students when they are handling with numbers. This is not so with Western languages such as English, where the pronunciations of some numbers may be more complicated (e.g. the number “seven” has two syllables).

The second characteristic is the regular nature of the Korean number system. In Korean, a consistent rule is applied to all numbers. For example, for numbers between eleven and nineteen, they are all pronounced as “ten followed by a single digit number”. There are no irregular numbers such as ‘eleven’ or ‘twelve’ in Korean. Similarly, numbers between twenty-one and twenty-nine are expressed as “twenty followed by a number”, and so on. In contrast, for numbers between thirteen and nineteen in the English language, they are pronounced as “a single digit number followed by ten”. For example, ‘16’ is pronounced as ‘sixteen’, with “six” followed by “teen” (which means ten). However, when it comes to numbers between twenty-one and twenty-nine, the pattern is changed to “twenty followed by a number”. This seemingly trivial inconsistency may cause problem for children when they learn and handle numbers, especially for young children at the lower grades of primary school. The Korean number system is a simpler and more logical system, easier for students to work with.

3. Attitudes of Students Towards Tests

Students’ performance in a test is obviously affected by their attitudes towards the test, and
this applies to international comparative studies well. In many Western countries, in order for students to take the TIMSS or PISA tests, the national study centers need to get prior approval from the parents concerned. This “voluntary” nature of taking the tests may have sent a signal to students that this is an activity that “does not count”, and hence students may tend not to take the tests seriously. In contrast, Korean students, who are raised in the Confucian culture, are educated to take testing very seriously. Their attitude towards the TIMSS and PISA tests may have been influenced by this general serious attitude towards testing and may have contributed positively to their performance.

4. Pragmatism and Repetitive Learning

East Asian lessons including Korean one are often criticized as a procedure-oriented teaching and learning rather than conceptually profound one. One explanation of the procedural teaching of Korean teachers can be offered by the pragmatic mentality in the East Asian culture. Korean teachers influenced by East Asian pragmatism choose to teach in a procedural manner which they think will work better as far as students’ performance in examinations is concerned. Within the classroom, this is manifested in the so-called Topaze Effect (Brousseau, 1997), where teachers may feel a kind of social contract in the role of a teacher and consider it a duty to efficiently deliver the content in a given time period.

If Korean students are exposed to such procedural teaching, why have they been doing so well in international studies? This is not an easy question to answer, but some preliminary thoughts will be offered. Recent literature on the East Asian learner seems to suggest that the “procedural teaching” in the East Asian classroom does not necessarily imply rote learning or learning without understanding. Actually, understanding is “not a yes or no matter, but a continuous process or a continuum” (Leung, 2001). The process of learning often starts with gaining competence in the procedure, and then through repeated practice, students gradually gain understanding. In the East Asian lessons, a set of practicing exercises that vary systematically, repeated practice becomes an important “route to understanding” (Hess & Azuma, 1991).

5. Competence of Mathematics Teachers

Recent studies (Ma, 1999; Leung & Park, 2002) suggest that East Asian teachers including Korean teachers have a more profound knowledge of fundamental mathematics than teachers in
the US, and this may be a factor contributing to the high achievement. Also we can find clues from looking into the system that selects teachers and supports their professional skills and knowledge.

In Korea, teacher education is provided at the Colleges of Education. Most students who enter the Department of Mathematics Education at the Colleges of Education are from the upper group in CSAT, and this trend is becoming more evident since the financial crisis in the late nineties. Moreover, some students enter the Department of Mathematics Education after completing their bachelor’s degree in other fields at a comprehensive university, making entry into these teacher training courses, and hence into the profession, very competitive.

Furthermore, completing the four-year education at a College of Education does not in itself qualify the graduates for teaching in public schools. The graduates are only awarded a teacher’s certificate which enables them to be eligible for teaching in private schools, but to qualify to teach in public schools, certificate holders are required to pass a very demanding national examination, the Teachers Employment Test (TET). The low success rate of TET has earned it a nickname of the ‘bar exam’ of the College of Education.

Most certificate holders choose to take the TET. The TET consists of three parts, encompassing general educational theory or pedagogical knowledge, subject matter knowledge, and pedagogical content knowledge. It ensures that teachers (in the public sector at least) have a firm grasp of the pre-requisite knowledge before they enter the profession.

In summary, the keen competition for pre-service teacher education and the demanding entry test to be a teacher ensure that teachers are selected from a pool of candidates with high scholastic achievement and are constantly updated with professional knowledge. Although we cannot simply conclude from these that Korean mathematics teachers must have profound knowledge in mathematics and are competent in pedagogy, it is reasonable to expect that Korean teachers are more competent in performing their roles than in many other countries where there is an acute shortage of mathematics teachers or a lack of support for their professional development.

6. Competence Cycle

Quality teaching tends to be “inherited”. Korean students, taught by competent teachers, acquire competence in mathematics. When they graduate and join the teacher force, they in turn become competent teachers, and once a good cycle starts, the positive effects cumulate and increa
singly reproduce themselves.

How did the good cycle start in the first place? One possible explanation may be the cultural values underlying these East Asian countries. It should be noted that the East Asian countries have been referring to share a common culture – that of Confucianism, referred to by some scholars (Biggs, 1996) as the Confucian Heritage Culture (CHC). The values under CHC that are of relevant to this discussion include:

- a strong emphasis on the importance of education
- high expectation for students to achieve
- attribution of achievement more to effort than to innate ability
- a serious attitude towards study
- the ideal of a scholar teacher

As suggested at the end, in Korea, the image of the teacher is that of an expert or a learned figure in the subject matter. Skills in teaching are of course also important, but no teacher will be respected if he is not an expert in the area that he teaches. This image of the scholar-teacher may provide incentives for Korean teachers to strive to attain competence in the subject matter and in teaching. And probably it is this prevailing cultural value of the emphasis on education and the scholar-teacher that starts and keeps the good cycle of competent teachers-competent students in Korea.

IV. Closing Remarks

This section is not meant to show how superior the Korean students are in their achievements in international studies of mathematics when compared to the other countries. It is meant to be an initial analysis to explore the factors that contribute to superior achievement. As can be seen from the this section, most of the factors for the high achievement are deeply rooted in culture, and so any further analysis should take explanations at the cultural level into account.

Without looking into the cultural factors that affect achievement at a deeper level, ranking countries according to achievement is not a very useful or meaningful exercise. The value of international studies of mathematics achievement lies not in these rankings, but in providing participating countries a common setting to identify factors that affect their students’ achievement. The international results also provide a contrast so that they can understand their own system better, and an opportunity to learn from other countries. After all, international
studies of achievement should not be about who is better, but should be about how we can provide a better education for our students.

References


