Constraints on the Intended Curriculum in Australia and Korea

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A recent large scale crossnational comparison on mathematics attainments

In a 1991 study (Educational Testing Service, 1992) of the mathematics attainments of 175,000 nine and thirteen year-old students from twenty countries (not including Australia), the (South) Korean and Taiwanese sample percentage means were equal, ten points below the mean of the sample of Chinese students which was the highest of the twenty countries. Then followed the means of the samples from Switzerland, The Soviet Union, Hungary, France, Italy, Israel, Canada and The British Isles, with the USA sample in equal thirteenth place with Spain.

The study also provided useful indicators of systemic and classroom influences in Korean mathematics attainment which can illuminate comparisons between Australia and Korea. The Korean population is 70% urban and 93% literate compared to Australia's 85% and 99%; Australia spends 5.3% of GNP on education compared with Korea's 4.5%; Australian students generally commence school in the year they turn 5 years of age, compared to Korea's students who start school at 6, and Australian Year 7 students have about 200 instruction days per year and 280 minutes of lessons per day, compared to Korea's 222 days and 264 minutes; average class size for Korea is 49 compared to Australia's 30; Korea has a national curriculum, while Australia has a National Statement on Mathematics (Australian Education Council, 1991b) and Profiles (Australian Education Council, 1993); Korean students tend to have less school mathematics instruction, with an average 179 minutes per week compared to Australia's 240, although on any school afternoon 40% of Seoul secondary students will go to after hours "cram" schools; in contrast to Australian Year 7 students, virtually all of whom use calculators in school, only 4% of Korean 13 year-old students use calculators in school; finally, 19% of 13 year-old Korean students have 4 or more brothers and sisters, compared to the 2.5% of 1991 Australian mothers who have four or more children. (Australian Bureau of Statistics, 1993a; 1993b)

A small crossnational study

There have been few recent crossnational studies comparing Korean students with those of other nations, and none reported with Australian students, which is surprising in view of the large concentrations of expatriate Koreans in various parts of Australia including Campsie in Sydney. This report sets out some brief comparisons between year 6 students in Korea and Australia, and draws some superficial conclusions about observed differences.

Test Material

The test material for this comparison was developed in Australia by G. Bell and N. Leeson as Examiners for the Australian Primary Mathematics Competition. It consisted of 50 items, with a time limit of 60 minutes, and calculators were not permitted. One item, involving axes of symmetry of English capital letters, was considered culture specific, and excluded from the analysis. The English version of the test was translated into Korean by Kang Ok-ki at Sun Kyun Kwan University, and then independently back translated into English by Korean-speaking personnel at the Asian Studies Centre at Griffith University. This back translation exhibited minimal differences from the original.

Following a content analysis of Australian primary curricula, the test items were developed in six categories comprising numeration, computation, shape, measurement, relation, and problem solving. The first five of these correspond to sections of the Korean curriculum, while the category "problem solving" is an integrated perspective, rather than a dedicated section in the Korean curriculum. At the time this study was implemented The National Statement on Mathematics for Australian Schools and the performance profiles which stem from it were not available, and The New South Wales curriculum "Mathematics K-6 " (Department of Education, NSW, 1989) was principally used to set the test content. It is set out in three sections - Shape, Measurement and Number (in that order) and "problem solving" receives explicit elaboration as a major reason for studying the subject on pages 20-25. In this exposition, mathematical problem solving is seen to encompass both the application of multi-step mathematical operations to the solution of problems arising from the environment, and "puzzling over and reasoning about questions that have arisen within a mathematical context." (p.20).

Precisely what constitutes "problem solving" is problematic (Schoenfeld, 1992). Carpenter (1985), for example, maintained that the superficially simple, one step problem "James had 13 marbles. He lost 8 of them. How many marbles does he have left?", involves real problem solving behaviour, especially in younger children. In the test for this study, problem solving items consistent with the

"Mathematics K-6" exposition comprised 39% of the total items. They consisted of non-routine questions judged by the writers to require the application of macro heuristics such as systematics, or creative and intuitive thinking beyond the simple application of a single mathematical operation. It is, of course, recognised that written multiple choice test items such as these may not always be accurate, or indeed valid (Schoenfeld, 1992; Davis and Waywood, 1992) measures of problem solving abilities, but they do have substantial currency in the assessment regimes of both countries, and were used here in that context. It is also recognised that the category "problem solving" is not mutually exclusive with respect to other categories, since problem solving items may require the use of number, computation, shape, and other concepts. The item numbers within each area are shown in Table 1, and sample items judged to fall into the problem solving category are shown in the appendix.

Subjects

The Korean students were from schools in Seoul and Pusan which volunteered for the study. All of the Grade 6 students at the volunteer schools completed the test items at one sitting in late 1992, two months into the school year. The sample size was 1671, drawn from unstreamed classes. The Australian sample numbered 1211, and was composed of those Year 6 students who appeared in a random Australia-wide sample of 2000 entries in the Year 5/6 Australian Primary Schools Mathematics Competition of August 1990. Privacy provisions imposed on the data stipulated that individual students, their characteristics, and their schools could not be identified.

Table 1. Classification of 49 Test Items.

	Number	Computation	Shape	Measurement	Relation	Problem-solving
Item Numbers	1, 3, 9, 28, 31	2, 4, 5, 6, 7, 25	12, 15, 37, 39, 43, 46	10, 14, 17, 18, 20, 21, 23	11, 24, 29, 34, 36, 40	8, 13, 16, 19, 22, 26, 27, 30, 32, 33, 35, 38, 41, 42, 44, 45, 47, 49, 50
Total	5	6	6	7	6	19

Representativeness of Australian Sample

The total entry for the Competition that year was 125,000, but it is not known whether the total entry for the Competition is representative of the Australian cohort, since not all eligible students enter. Some schools enter their entire year cohort in order to monitor student progress from year to year, but most schools call for entries and encourage those who are reasonably confident in mathematics. Anecdotal inquiries conducted by the Australian researcher indicate that it is likely that the total entry for the competition probably is more representative of the most competent half of the total eligible Australian cohort. Table 2 shows the distribution of the various samples. Students in the Australian sample who did not indicate their gender or school region numbered 68.

Table 2. Distribution of Samples

	Female	Male	Total
Korea			1671
Seoul	502	503	
Pusan	314	324	
Australia			1143 (1211)
Metropolitan	538	521	
Rural	47	37	

Data Analysis

Answers were graded either correct or incorrect, with a score of one for a correct answer. Maximum score was therefore 49, and the proportion correct out of 49 was converted to a percentage. Table 3 shows the achieved scores as mean percentages for male and female students, with standard deviations in parentheses. "t" tests were carried out on gender and total differences, and 0.01 significance levels are marked by *.

Table 3. Korean and Australian Students: Mathematics achievement scores as mean percentage, standard deviations (in brackets), and "t" test results on gender and total differences.

	Korea				Australia				
	Total (1671)	Female	Male	Gender Signif-icance of "t"	Total (1211)	Female	Male	Gender Signif-icance of "t"	Total Signif-icance of "t"
Number	65.25 (24.72)	64.34 (24.25)	66.13 (25.14)	NS	58.73 (23.37)	59.29 (24.38)	59.09 (22.35)	NS	*
Comput-ation	84.00 (16.48)	83.42 (16.43)	84.56 (16.51)	NS	77.59 (15.51)	80.31 (17.48)	76.30 (20.34)	*	*
Shape	47.03 (25.04)	45.22 (24.33)	48.75 (25.60)	*	32.92 (22.17	31.48 (22.04)	34.71 (22.44)	NS	*
Measure	64.89 (23.80)	63.27 (23.38)	66.43 (24.10)	*	68.59 (22.95)	67.47 (23.36)	70.73 (22.18)	NS	*
Relation	59.90 (24.47)	58.33 (24.18)	61.40 (24.67)	NS	52.70 (24.39)	51.88 (23.22)	54.48 (25.43)	NS	*
Problem-solving	43.29 (16.23	41.62 (15.63)	44.48 (16.63)	*	39.78 (17.36)	39.07 (16.41)	41.34 (18.22)	NS	*
Total	56.09 (15.50)	54.63 (14.94)	57.48 (15.91)	*	51.20 (15.51)	50.88 (14.82)	52.43 (16.03)	NS	*

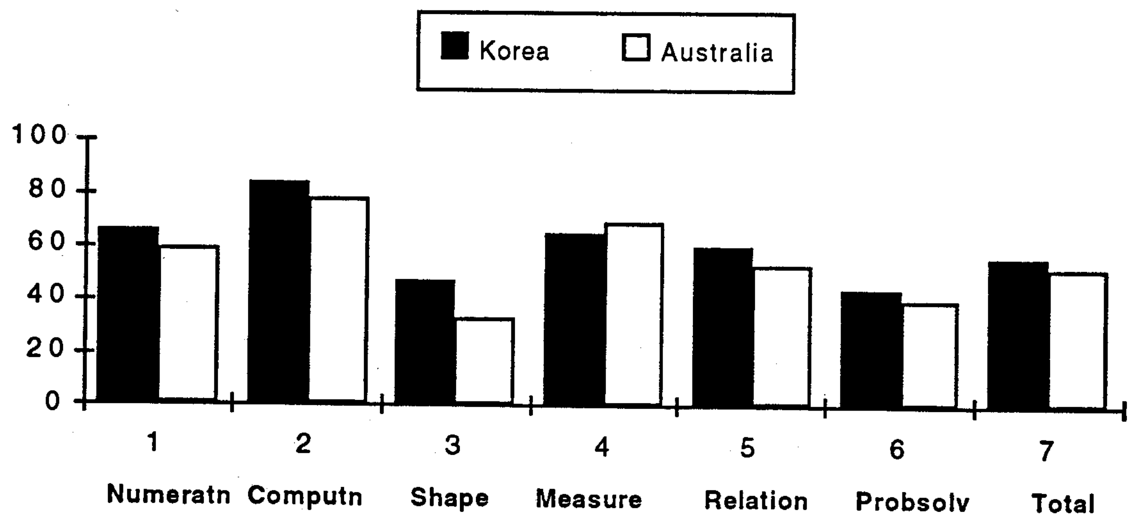
Korean students gained relatively high scores on computation, number, measurement and relations, while mean percentage scores on shape and problem solving were roughly half the scores on computation. Male scores were consistently higher than female, and significantly so in every area except number (and numeration) and computation.

Scores for the Australian sample were relatively high on computation and measurement, but quite low on shape and problem solving.

The Korean sample exhibited higher means in numeration, computation, shape, relations, and problem solving, while the Australian sample scored higher on measurement. All of these mean differences were significant at the 0.01 level, although inferences on selective samples such as these may not be valid.

It is interesting to speculate on the reasons for the possible superiority of the Australian sample in measurement. One might suggest that the measurement units used in each country might be a factor, but this is unlikely. Korea does have "traditional" units which have some currency, as well as marginal use of American "imperial" units, but metric units were introduced at about the same time as they were in Australia, so the experiences in each country are broadly similar.

Fig.3 Korea/Australia - Mathematics mean achievement percentage



Discussion - Curriculum Rhetoric and Curriculum Reality on Gender and Problem Solving

Gender is generally seen to be an important variable in mathematics attainment in Australian curriculum documents (see, for example, Australian Education Council, 1991b, page 9; NSW Department of Education, 1989, page 38), but the issue is complex. For example, female test responses tend to differ in terms of omission rates, with females consistently omitting more items than males, and this has sometimes been interpreted as an indicator of diminished risk behaviour in females (Atkins, Leder, O'Halloran, Pollard and Taylor, 1991).

The superior results for female Australian students over their male counterparts on numeration and computation seen in the present study in Table 3 are encouraging, and consistent with recent years' results on the Australian Primary Mathematics Competition, which show that females outperform males on straightforward computations, while exhibiting lower overall test scores (see also, Annice, Pollard & Taylor, 1990).

The consistent superior results of male over female in the Korean data (Table 3) emphasises the strong gender differentiation found in Korean society, and having its roots in cultural traditions. Compared to their American counterparts, thirteen year-old Korean students are twice as likely to agree with such statements as "Men make better scientists and engineers than women", "Boys have more natural ability in mathematics than girls", and "Boys need to know more mathematics than girls". And they are also about half as likely to agree with "A woman needs a career just as much as a man does" (Paik, 1991).

In Korea, the Sixth Mathematics Curriculum was published in 1992, and textbooks to support that document have recently been prepared. There is only one set of approved textbooks for primary schools, and these, along with School Principals, stand as the primary reinforcers of curriculum. It would be interesting to undertake an examination of both of these curriculum agencies in order to determine whether there has been any change towards a more equitable gender emphasis.

Problem solving

The lower mean scores of samples from both countries on the problem solving items are of particular interest, because the development of problem solving ability is an important aim of both Korean and Australian mathematics curricula. The introduction in the Korean Primary School Mathematics Curriculum (1992) states:

1. **Features**

Mathematics is a subject which facilitates development of logical thinking and rational problem solving abilities and perspectives, by developing and bringing together the understanding of basic mathematical concepts, principles and rules, hence, enabling observation and consideration of material phenomena in a mathematical way.

Algebra and number relations, geometrical concepts, logical thinking, and rational problem solving abilities and perspectives are necessary components of successful learning of most scientific subjects. Modern society in the information age requires an intelligent approach to selecting and classifying data generated in everyday life experiences.

Mathematics in the primary school, in order to cultivate the aptitudes required for the information society, focusses on rational problem solving skills for various problems which may occur in life situations, through:

- a good understanding of basic algebraic and geometrical concepts, principles and rules,
- proficiency in mathematical operations, and
- development of mathematical thinking ability.

Mathematics places emphasis on the development of basic learning skills and rationally based problem solving abilities. Therefore, teaching and learning should be approached not with computation exercises, but with a focus on advancement of basic learning skills, and development of mathematical thinking and problem solving ability. (Bell and Lah, in press)

The National Statement on Mathematics for Australian Schools, in setting out the goals for school mathematics, states "Students should develop their capacity to use mathematics in solving problems individually and collaboratively" (page 12), and goes on to suggest that students at upper primary levels should have experience in using a range of problem solving strategies, in refining and extending mathematical questions, in undertaking structured investigations, and in using personal and group skills to solve mathematical problems (page 49). These intentions and emphases are intended to articulate with problem solving aspects of recently developed employment-related key competencies (Australian Education Council, 1991a: Mayer, 1992; page 37), as well as with National Profiles in Mathematics (Australian Education Council, 1993).

Conclusions

On these limited samples, gender differences in mathematical attainment continue to manifest in both Australia and Korea, although those in Australia show some cause for hope of a more balanced attainment. If mathematics educators really believe that mathematical knowledge benefits not only those individuals who receive it but also, through equity and the maximisation of effective use of abilities, the societies to which they belong, then much remains to be done in both countries.

Korean students in the present study significantly outperformed their Australian counterparts on problem solving items, but the results of neither sample were convincing. If the crossnational data reported above can be accepted as valid within their limited context, it is problematic whether the intentions with respect to problem solving which are enunciated in the curricular statements of both countries are really being fulfilled.

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