International Project on Mathematical Attainment
Performance of Singapore Pupils – Some Significant Findings

Berinderjeet Kaur, Koay Phong Lee, Yap Sook Fwe
Mathematics & Mathematics Edn AG
National Institute of Education
Nanyang Technological University
Singapore

Introduction

Singapore joined the International Project on Mathematical Attainment (IPMA)* in January 1999. This project is a longitudinal and international one (Burghes, 1998a). Brazil, China, Czech Republic, England, Estonia, Finland, Greece, Hungary, Ireland, Japan, Poland, Russia, Singapore, South Africa, Ukraine and United States of America participated in the project. The aim of this project is to monitor the mathematical progress of children in primary school from the first year onwards. It hopes to study the various factors that affect that progress, with the ultimate aim of making recommendations at an international level for good practice in the teaching and learning of mathematics.

The Study

Sample

A total of 856 pupils studying in three primary schools in Singapore participated for five years in the study. The subjects are entire cohorts of Primary One pupils in 1999 from these schools.

Instrument

The tests used in the study were constructed by the IPMA team (Burghes, 1998b) at the Centre for Innovation in Mathematics teaching at the University of Exeter in the United Kingdom.

* This project is funded by the Academic Research Fund, National Institute of Education, Nanyang Technological University, Singapore RP 21/98 BK and the University of Exeter, UK.

Procedure

In a school, the pupils were given the test scripts at the same time. Pupils were not told in advance about the test and therefore did not prepare for it in any way. In Primary One and Two, teachers read through the test with the help of overhead transparencies, item by item, allowing sufficient time for pupils to answer an item before proceeding to read the next one. Teachers were allowed to paraphrase the items so that pupils' performance was not affected by language competency. In Primary Three, Four and Five teachers did not offer any assistance and pupils worked through the tests on their own.

Data collection & analysis

The test scripts were scored by the research team at NIE. The answers were marked either right or wrong. A score of one was given to a correct response and zero for an incorrect response. The Minitab statistical software was used to analyze the data. The mean and standard deviation of the test scores and item difficulty indices were obtained for all tests. For Test 1 scores, the relation of test scores to types of pre-school attended was also examined. A qualitative study of errors made by pupils for all tests was carried out.

Results

The table below shows the means and standard deviations of the Tests 1 – 6 for the pupils from Singapore.

Means and Standard Deviations of Tests 1 – 6 for all pupils

Test	Max Mark Possible	Mean	Standard Deviation
1	20	15.70	3.26
2	40	30.41	5.58
3	60	45.66	7.54
4	80	59.54	9.73
5	110	85.26	13.94
6	140	106.12	17.23

Significant Findings from the Tests

From the data of Test 1 and the information obtained from school records about the types of pre-schools (Kaur, Koay, Yap & Burghes, 1999; Kaur, Koay & Yap, 2000) that the pupils attended it was found that:

- The performance of Primary One pupils in Test 1, show that in Singapore, children generally enter Primary One with considerable knowledge in arithmetic. The two or three years of pre-school education seems to give children a head-start in mathematics at school. They are able to count to twenty, distinguish common shapes, complete simple number sentences involving addition and subtraction within 20. They tend to use finger counting to find the answers.

- There was insufficient evidence to conclude that the pre-school type has an effect on pupil performance in mathematics at the beginning of Primary One. As there were greater differences among schools than between pre-school type within the school, the differences in performance may be attributed to other confounding factors such as locality of school, social economic status of pupils, family support, etc.

From the results of Tests 2 – 6 (Kaur, Koay & Yap, 2000; 2001a; 2001b; 2003; Koay, Kaur & Yap, 2001; Koay, Yap & Kaur, 2003; 2004) for all the pupils it was found that:

- Pupils did well on test items focused on topics that they had been taught in school. Also, there appeared to be a coherent coverage of topics across year levels in all the three schools. This is a result of a common mathematics syllabus across all primary schools in Singapore.

- About 5 % of the cohort persistently obtained low scores in the tests, indicating that they have not mastered the basic mathematical concepts and skills taught. Streaming them at the end of Primary Four to the EM3 stream did not seem to improve their performance.

- From the test scores of all the Tests, it also appears that there are pupils who are able to correctly answer some items with assessment objectives beyond their current mathematics curriculum, in particular items on probability.

- The performance of pupils on items in the following areas is not satisfactory.
  - Representation using number lines
  - Estimation skills
  - Problem solving heuristics, in particular, working backwards
  - Checking reasonableness of answers to word problems

Pedagogical Implications

Some implications arising from the findings of the study include the following:

- The primary mathematics curriculum is well structured and generally well learnt by a majority of the pupils. However, there is a need for a differential curriculum in school to cater to the needs of pupils with different mathematical abilities. For pupils with low ability, the current EM3 practice of reviewing topics taught in Primary One to Four at a slower pace in Primary 5 and 6 often using drill and practice is inadequate. There is an urgency to develop a more innovative hands-on pedagogy that promotes understanding. For pupils with high mathematical ability, teachers should provide opportunities to stretch them through both horizontal and vertical enrichment activities.

- There is room for improvement in the instruction of mathematics in the primary schools in the following ways:
  - Increase the use of a number line to provide a visual representation of the relationships among whole numbers, decimals and fractions, display operations, equivalence and solutions to problems.
  - Increase the emphasis on the use of estimation skills, particularly in checking of arithmetic computations.
  - Increase the emphasis on reasoning, explaining and sense making. Provide pupils with opportunities to articulate the process they use to solve a problem, suggest alternative solutions and reflect on what they have done.

Conclusion

This longitudinal study has shed light on some of the strengths and weaknesses of teaching and learning of mathematics in Singapore's primary schools. The primary aim of the mathematics curriculum is to enable pupils to develop their mathematical problem solving ability, which in turn depends on five-interrelated components: concepts, skills, attitudes, metacognition and processes. Apparently, most of the pupils in the study have acquired the basic concepts and skills for mathematical problem solving. However, we need to consciously and seriously consider the other components to make the learning of mathematics a meaningful and lifelong endeavour.

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List of Seminars, workshops, international meetings arising from the Project (RP 21/98 BK) International Project on Mathematical Attainment (IPMA)

Meetings with HoD and Teachers from Participating schools

Purpose: To disseminate data and results of the project (3)

1) 26th April 2001 from 11am – 1 pm @ Woodlands Primary School
meeting with teachers involved with the project and sharing with them their pupils' performance.

2) 5th April 2000 from 1.30 – 3.30 pm @ Woodlands Primary School
meeting with teachers involved with the project and sharing with them their pupils' performance.

3) 12th May 1999 from 11am – 12.30 pm @ Woodlands Primary School
meeting with teachers involved with the project and sharing with them their pupils' performance.

Seminar / Workshops for Teachers from Participating Schools

Purpose: Professional Development (4)

1) 21st March 2002 from 2.30 – 5.15 pm @ Ai Tong School
[29 teachers attended]
2) 19th Nov 2001 from 9.00 am – 12.30 pm @ NIE
[29 teachers attended]
3) 28th May 2001 from 9.00 am – 12 noon @ NIE

[28 teachers attended]

4) 14th April 2000 from 2 – 5 pm @ NIE
[26 teachers attended]

MME Staff Seminar

Purpose: Sharing with colleagues in MME and NIE (1)

1) 27 April 2001 from 1.30 – 2.30 pm

International Project Meetings

Purpose: To share the findings from Singapore with colleagues from other participating countries (5)

1) 5th and Final Coodinators Meeting 2nd – 4th July 2004 in Lund (Sweden)

2) 4th Coordinators Meeting 10th – 12th October 2003 @ Manreza Conference Centre, Dobogoko, (Hungary)

3) 3rd Coordinators Meeting 8th – 11th March 2002 @ PricewaterhouseCoopers Conference Centre, Latimer, Buckinghamshire in the UK.

4) 2nd Coordinators Meeting 15th – 18th June 2000 @ PricewaterhouseCoopers Conference Centre, Latimer, Buckinghamshire in the UK.

5) 1st Coordinators Meeting 19th – 21st February 1999 @ PricewaterhouseCoopers Conference Centre, Latimer, Buckinghamshire in the UK.

Publications arising from the Project RP 21/98 BK International Project on Mathematical Attainment (IPMA)

Research Reports (5)

Koay, P.L., Yap, S.F. & Kaur, B. (2004). *IPMA Report (NIE – Exeter Joint Study) – Year Five (Jan – Dec 03)*. Singapore: National Institute of Education, Mathematics & Mathematics Education Academic Group, Nanyang Technological University.

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Kaur, B., Koay, P.L., Yap, S.F. & Burghes, D. (2001). International Project on Mathematical Attainment. *The NIE Researcher*, 1(1)**,** 11-12. Singapore: National Institute of Education.

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