The Changing Face of Assessment in Singapore: The Case of Mathematics in Primary Schools

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Introduction

> *…a shift in mindset about assessment is necessary to balance the learning of knowledge with the development of important life-skills, as well as to focus on the learning process instead of just educational outcomes.*
>
> Primary Education Review and Implementation Committee
> (Ministry of Education, 2009a, p. 5)

Examination has always been an important part of assessment in Singapore schools. There are three national examinations, taken at the end of grade six, grade ten and grade twelve. This paper is on the changing face of assessment in Singapore schools, with a particular focus on assessment of mathematics learning in primary schools. Such changes must be supported by corresponding professional development of teachers and this paper suggests how assessment tasks can play an important role in teachers' professional learning in the lesson study process.

In the first part, a brief overview of assessment tools in the Singapore education system is presented. In the main parts of the paper, changes in assessment of mathematics learning in primary school are discussed under three broad areas (1) the inclusion of alternative assessment tools, (2) the introduction of calculator in the primary school national examination, and (3) the expectation to solve challenging problems in the national examinations.

System-Wide Assessment Practices in Singapore

Since 2003, it has been made compulsory for all Singaporean students to complete a six-year primary-school education in a public school and sit for the Primary School Leaving Examination (PSLE) (Ministry of Education, 2010). The small number of students who are home-schooled or study in the *madrasahs* (Islamic religious schools) are also required to sit for this examination. At present, this is the only assessment that is legally compulsory.

Pre-school education is not compulsory and not part of formal schooling. Although most students attend one of the many types of kindergartens available, there is a small number of students who do not have pre-school education. There is no assessment to admit students into primary schools, which are all essentially public schools. In the case of mathematics and English language, there is a diagnostic assessment to determine if a student is ready for grade one. Those who are assessed to be not ready are provided with the necessary support in the form of the Learning Support Programme where a pull-out programme enables students to receive more teacher attention in smaller classes for the first two grades. There is a maximum of 30 students in a regular class for the first two grades. Learning Support Programme classes typically have fewer than ten students.

Secondary school education is not compulsory but it is extremely rare to find teenagers who do not attend school. The national examination results at the end of grade six plays an important role in determining the secondary school that students get admitted into. However, it is not the only criteria to determine a student's secondary school. Many students are admitted into their secondary school using criteria other than their grade six national examination results. For example, some schools assess students on their special talents (e.g. excellence in a sport, interest in science and mathematics or skills in one of the performing arts). The provision of such assessment is in place under a scheme called Direct School Admission (DSA). Presently about half of secondary schools in Singapore offer this type of assessment for student admission (Ministry of Education, 2009b).

Students complete either a four-year or five-year course in secondary school before the either proceed to a junior college, where they study academic subjects, or a polytechnic, where they study a vocational course. Students who do well proceed to study in one of the four local or other foreign universities. At each stage, national examination results play an important role. Most students use their results in the national examination taken at the end of grade ten to obtain admission to one of the junior colleges or polytechnics. There are exceptions for a smaller group of high-achieving students who study in the Integrated Programme (see http://en.wikipedia.org/wiki/Education_system_in_Singapore#Integrated_Programme). They do not take the national examinations at the end of grade ten. Students in this programme are assessed using school-based assessment.

At the end of grade twelve, most students sit for the national examinations, the General Certificate of Education Advanced Level. A smaller number of schools offer an alternative to the grade twelve national examinations in the form of the International Baccalaureate Diploma. One high school, which is linked to one of the universities, offers their own diploma.

In general, it can be seen that the Singapore education system, which has always placed a strong emphasis on examinations, is attempting to find a balance so that students are equally strong in knowledge and skills, and teachers place equal emphasis on process as well as product of learning.

Mathematics Assessment in Primary Schools: More Varied Assessment Modes

The system of having two semestral assessment and two continual assessment in one school year is well ingrained in Singapore schools. There was a time when schools modeled such semestral assessment and continual assessment after the grade six national examination. Thus, students in all grade levels used to have four written examinations in a school year. Students in the first four grades used to typically do written examinations with twenty multiple-choice items, twenty short-answer items and five long-answer items while students in the grades five and six used to complete examinations with the same format as the grade national test, comprising of fifteen multiple-choice items, twenty short-answer items and more than ten long-answer items. While one can still find primary schools in Singapore with this practice, they are now far in between.

While semestral assessment in grade three onwards are still invariably written examinations, there have been efforts by schools to introduce a range of alternative assessment as continual assessment. This is in part due to the exhortation by Ministry of Education. For example, in the first two grades, Ministry of Education recommended that, "when students are just beginning school, a key focus should be placed on building pupils' confidence and desire to learn" (Ministry of Education, 2009a, p. 5) and schools are asked to "move away from an overly strong emphasis on examinations, and explore the use of bite-sized forms of assessment which place more emphasis on learning rather than on grades alone" (Ministry of Education, 2009a, p. 5).

Thus, generally, there is a definite shift from using written examination as assessment to combining written examination with other forms of assessment. In particular, teachers in the first two grades are expected to use more of such alternative assessment modes. For an education system that has an established culture of written examination, it is expected that teachers will need help in developing and implementing other modes of assessment. While pre-service courses for primary mathematics teachers devoted more than 10% of the entire training on test item writing, there is no corresponding emphasis on designing other forms of assessment tasks. In fact, since 2006, National Institute of Education has offered a three-hour lecture on alternative assessment in the lower primary classrooms with examples in English Language and mathematics. While it serves as an introduction to the use of alternative assessment modes, this is clearly inadequate in equipping teachers with the expertise they need to implement the assessment reforms exhorted by Ministry of Education.

The Use of Calculator in PSLE Mathematics

The Singapore mathematics curriculum was introduced in 1992 and was revised in 2001 and 2007. The 2007 revision also introduced the use of calculator in a part of examination for upper primary levels (Ministry of Education, 2007). Students are expected to use a calculator for the problem-solving section of the primary school leaving examination (PSLE), which constitutes half of the total score.

According to the Ministry of Education (2007), the introduction of the calculator aims to enhance the teaching and learning of mathematics. It should facilitate "more exploratory approaches" to the learning of concepts and allow students to focus on "discovering patterns and making generalisations". It should also facilitate the use of more authentic data, which difficult to work with without the use of calculator. This will help students see the "connections between mathematics and the world around them".

An example of an item where students are likely to use the calculator is shown in Figure 1.

> The price of one curry puff from Super Puff Shop is 80 cents.
> When a customer buys 3 curry puffs, he can buy one more at half the price.
> What is the **greatest** number of curry puffs that a customer can buy with $50?

Figure 1: Curry Puffs Problem (SEAB, 2009, p. 32)

How can teachers plan a mathematics programme that ensure that students do not reach out for a calculator when they are doing computations to find the price of three curry puffs or half of 80 cents? How do teachers teach students so that they can make sense of the numbers they see on the display of a calculator when they use a calculator to compute, say, $50 ÷ $2.80?

Again, Ministry of Education has conducted introductory workshops on the use of calculators for teacher teaching in the upper primary grades. Further professional development in this area is needed to equip teachers with expertise to fully reap the benefits of using calculator in teaching and learning of mathematics.

The Provision for Mathematical Challenge in PSLE Mathematics

A significant proportion of examination items in the national examination for grade six students provide students with challenging situations (de Losada, Yeap, Gjone & Pourkazemi, 2009). This emphasis on challenging problems came into being with the introduction of a problem-solving curriculum in 1992 and national examination based on this curriculum in the late 1990s. Figures 2, 3 and 4 show that students are required to apply their understanding and knowledge in a variety of relatively complex situations and to explain their reasoning. These are characteristics of students in the advanced benchmark level in the Trends in Mathematics and Science Study 2007 (TIMMS2007).

> Mrs Hoon made some cookies to sell. $\frac{3}{4}$ of them were chocolate cookies and the rest were almond cookies. After selling 210 almond cookies and $\frac{5}{6}$ of the chocolate cookies, she had $\frac{1}{5}$ of the cookies left.
> How many cookies did Mrs Hoon sell?

Figure 2: Cookies Problem (SEAB, 2009, p. 20)

In the Cookies Problems, students need to apply their understanding and knowledge of fraction as part of a set in a situation where there is more than one set. The complexity in this problem is in part due to the fact that students have to deal with fractions of different sets.

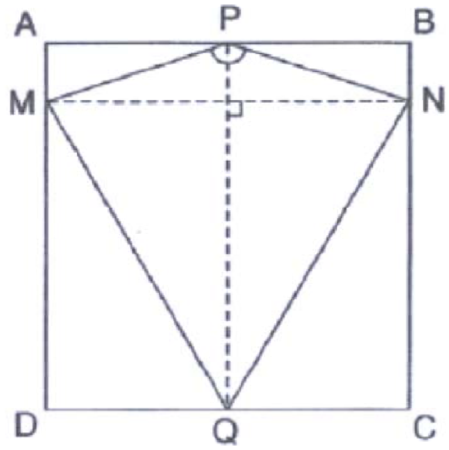
> Jim bought some chocolates and half of them to Ken. Ken bought some sweets and gave half of them to Jim. Jim ate 12 sweets and Ken ate 18 chocolates. After that, the number of sweets and chocolates Jim had were in the ratio 1 : 7 and the number of sweets and chocolates Ken had were in the ratio 1 : 4. How many sweets did Ken buy?

Figure 3: Chocolates & Sweets Problem (SEAB, 2009, p. 70)

In the Chocolates & Sweets Problem, student who know the basic interpretation of a ratio $x : y$ may not necessarily be able to solve this problem. The complexity in this problem is due to the fact that one unit in 1 : 7 and in 1 : 4 are not the same unit. In the two word problems in Figure 2 and Figure 3, students have to deal with a set of conditions that have to be met simultaneously. This adds to the complexity of these problems. In all these problems, students receive more credit for explaining their reasoning than obtaining a correct final answer.

The Square Problem is based on sum of angles in a triangle and properties of equilateral and isosceles triangle. However, students with this knowledge may not necessarily be able to solve this problem. Students who are successful need to be able to pick out the equilateral and isosceles triangles which depends on their ability to do visualization.

In the diagram below, ABCD is a square and QM = QP + QN. MN is parallel to AB and it is perpendicular to PQ.



Find ∠MPN.

Figure 4: Square Problem (SEAB, 2009, p. 65)

Also, some problems have an element of novelty. For example, in the examination in 2000, students were asked to find the ones digit in the sum of the first 97 whole numbers 1 + 2 + 3 + 4 + 5 + … + 95 + 96 + 97. Subsequently efforts had been put in to teach students to solve variation of this problem. For example, one of the textbook series included a problem on finding the ones digit in the sum of all odd numbers in the first 99 whole numbers (Fong, Gan & Ramakrishnan, 2009, p.63). No variation of this problem has appeared in the subsequent examinations.

It is clear from the examples taken from one year's examination paper that the items on the national examinations require students to be able to handle significant mathematical challenge. Does clear explanation of solutions help students solve other challenging problems that are not similar to the ones students have encountered before? Does adequate practice of certain problem types enough to help student solve problems not encountered previously? Do teachers have adequate knowledge, pedagogical or otherwise, to help average students and struggling ones solve such problems? What kind of professional development tools are available to equip teachers sufficiently to handle this task?

A common response from schools to this demand of the curriculum is to provide instructional programmes and assessment items that are at least of the same level of challenge. Figure 5 shows a typical textbook problem and a corresponding problem based on the same mathematical idea. It is common for schools to provide students with a set of teacher-constructed problems after students have solved textbook problems. Thus, my experience with primary schools in Singapore indicates that schools include problems that are more challenging than textbook ones in their instructional programme.

Textbook Problem	School's Problem
Luke collected 548 coins. Luke collected 276 fewer coins than Sam. How many coins did Sam collect? (Fong, Ramakrishnan & Choo, 2007, p.42)	A lion weighs 135 kg. A cow weighs 87 kg more than the lion. An elephant weighs 139 kg more than the cow. How heavy is the elephant?

Figure 5: Comparing Textbook Problems and School's Problem

No research is necessary to conclude that the problems in Figure 5 are commonly included in schools' examinations in the upper primary levels. The problems are taken from examinations of three different schools.

The number of goldfish in Tank A is $\frac{7}{12}$ of the total number of goldfish in Tank A and Tank B. If 39 goldfish are taken out from Tank A, the number of goldfish left in Tank A is $\frac{3}{4}$ of the number of goldfish in Tank B. Find the total number of goldfish in the two tanks at first.
Using $\frac{3}{5}$ of his money, Teck Ming could buy 8 similar pens. If he was given an extra dollar, he could use it together with the rest of his money to buy another 6 such pens. How much money did Teck Ming have at first?
The tickets for a show are priced at \$10 and \$5. The number of ten-dollar tickets available is $1\frac{1}{2}$ times the number of five-dollar tickets. 5 out of 6 ten-dollar tickets and all the five-dollar tickets were sold. The ticket sales amounted to \$5 600. How much more would have been collected if all the tickets were sold?

Figure 5: Common Challenging Problem in Schools' Examinations

Although there is already a generally high level of achievement among students by the end of six years[1], some perennial questions remain. How can teachers help more students reach an adequate level of competency in handling challenging materials? What do teachers need to know in order to help students more effectively? How do teachers acquire such knowledge?

Conclusion

This paper has outlined the changes in assessment of mathematics learning in Singapore. This includes the introduction of a wider array of assessment tools, the use of calculators in problem solving and the prevalence of challenging problems in national examinations. Such changes must be supported by relevant professional development for teachers so that they are not struggling or merely coping with the changes. That would allow teachers to rise above the changes and develop the necessary expertise.

References

de Losada, M. F., Yeap, B. H., Gjone, G., & Pourkazemi, M. H. (2009). Curriculum and Assessment That Provides Challenge in Mathematics. In E. J. Barbeau & P. J. Taylor (Eds), Challenging Mathematics In and Beyond the Classroom. New York: Springer.

Fong, H. K., Ramakrishnan, C. & Choo, M. (2007). My Pals Are Here! Maths 2A Workbook Part 1 (Second Edition). Singapore: Marshall Cavendish Education.

[1] In 2009, the national average for students who received A* or A was 43.3%. This is a typical result in recent years. Students who scored A* or A must have been fairly successful with the challenging problems discussed in this paper. In 1960, 45% of the 30 615 candidates passed the first ever national examination for primary school students (Tan, Chow & Goh, 2008).

Fong, H. K., Gan, K. S & Ramakrishnan, C. (2009). My Pals Are Here! Maths 6A (Second Edition). Singapore: Marshall Cavendish Education.

Ministry of Education. (2007). Introduction of Calculators in Primary 5 and 6 Mathematics (Press Release). http://www.moe.gov.sg/media/press/2007/pr20070427.htm

Ministry of Education. (2009a). Report of the Primary School Review and Implementation Committee. Singapore: Author.

Ministry of Education. (2009b). Direct School Admission: Secondary Exercise 2009 for Admission to Secondary One in 2010. http://www.moe.gov.sg/education/admissions/dsa-sec/

Ministry of Education. (retrieved on 16 February 2010). Compulsory Education. http://www.moe.gov.sg/initiatives/compulsory-education/

Singapore Examinations and Assessment Board (SEAB). (2009). PSLE Mathematics Examination Questions 2005 – 2009. Singapore: Educational Publishing House.

Tan, Y. K., Chow, H. K & Goh, D. (2006). Examinations in Singapore: Change and Continuity (1891 – 2007). Singapore: World Scientific.

Appendix

The Appendix gives an example on the use of assessment tasks in the lesson study process.

In the lesson planning stage of a lesson study where the research lesson was a grade-two lesson on fractions, the facilitator gave the lesson planning team an item from a recent year national examination.

In the research lesson, students were supposed to learn to find the fraction of a given figure that is shaded or not shaded.

ABCD is a square. The shaded parts X and Y are two squares with different areas. All the corners of squares X and Y lie either on the sides of square ABCD or on the line AC.

What fraction of the square ABCD is shaded?

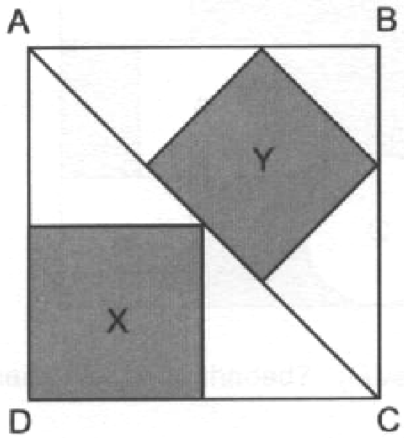


Figure 6: Fraction Problem (SEAB, 2009, p. 13)

- Solve the problem together.
- What are the key mathematical concepts or skills that you used along the way.
- Share some errors that were made initially
- One error was to conclude that half the square is shaded. Discuss.
- Another error is this reasoning: As X is $\frac{1}{2}$ of triangle ADC and Y is $\frac{4}{9}$ of triangle ABC, the area of the square that is shaded is $\frac{1}{2}+\frac{4}{9}$. Discuss.
- Compare this task to the tasks in the primary two textbooks.