Out-of-School PSLE Mathematics Practice Books in Singapore

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At the end of Primary 6, students in Singapore schools take a national examination, the Primary School Leaving Examination (PSLE). Society at large view the PSLE as a high-stakes examination. In addition to out-of-class work assigned by mathematics teachers for students to prepare for the PSLE mathematics, parents may also draw on out-of-school practice books to further support their children's preparation for the examination. A study of two main types of such books show that these books do generally support students in reviewing content knowledge for the examination and test preparation.

The Primary School Leaving Examination (PSLE) is a national examination in Singapore. It is conducted by the Singapore Examinations and Assessment Board (SEAB). It is taken by 12-year-olds at the end of their primary schooling. The examination tests student's proficiency in the English language, their respective mother tongue languages (typically Chinese, Malay or Tamil), mathematics and science. The purpose of PSLE is to emplace students in a course of study that is suited to their learning ability in a secondary school. Singaporeans place great emphasis on education and examinations are gatekeepers to educational opportunities throughout the Singaporean educational education system (Gregory & Clarke, 2003). As such the PSLE is viewed as a high-stakes examination by society at large (Loke, 2016).

Though out-of-school mathematics practice books, particularly those for the PSLE, have been available for the last three decades or more, there appears to be no apparent study on these books in Singapore. This study that is part of a larger study (Teo, 2023) attempts to explore the research question: How do the PSLE Mathematics practice books support test-taking preparation and test-taking skills for the PSLE Mathematics?

Examination Preparation

In addition to out-of-class work assigned by mathematics teachers for students to prepare for examinations, like the PSLE, parents may also draw on out-of-school practice books to further support their children's preparation for examinations. The PSLE examination for mathematics (PSLE Mathematics), is a paper-based examination, i.e., students respond individually to a set of questions in writing under supervision of examiners. To be successful, students require the skill or ability to do the mathematics within a given time frame. The development of these skills or abilities—influenced by the nature of the examination appears to be pertinent in examination preparation (Minott, 2020).

Examination preparation with a goal to enhance learning may take several forms, such as review sessions and or practice examinations (Bord, 2008). Review sessions allow students to clarify their questions about content, procedures, etc., that they will be tested on (Gurung, 2005). Practice examinations would involve students doing mock examination or past examination papers in a similar manner to that of the examination. Balch (1998) noted that practice examinations in contrast to review sessions led to positive gains in student performance in final examinations. In the study by Muchiri and Mawira (2020), it is evident that mathematics practice has positive impact with or without teacher's intervention as it gives "students an opportunity to attempt and familiarise themselves with questions and the way they are set in an exam" (p. 539).

Naujoks et al. (2022) noted that practice tests function as a (repeated) retrieval opportunity, which has the potential to empower future learning, recall and recognition. In addition, it is also

(2024). In J. Višňovská, E. Ross, & S. Getenet (Eds.), *Surfing the waves of mathematics education. Proceedings of the 46th annual conference of the Mathematics Education Research Group of Australasia* (pp. 519–526). Gold Coast: MERGA.

suggested that practice test participation establishes potentials for learning processes like metacognitive judgement accuracy (Karpicke & Roediger, 2008). Students who do practice tests have an idea of how well they would do on an exam without any further practice or studying and this allows them to adjust their studying accordingly or focus on areas that may need more of their attention (Balch, 1998). A practice exam engages the student in self-assessment and metacognition. They can see their scores on the practice exam, evaluate their confidence with the tasks and assess what they know and what they need to study further or seek help with (Bord, 2008).

Students must be proficient in test-taking for the test to adequately serve as a measure of their mastery of a learning content (Dixon & Erinosho, 2020). It is possible to have knowledge of the content of a subject but perform poorly on a test due to poor test-taking strategies. The ability to utilise appropriate strategies to demonstrate competence and perform at optimal level on a test is referred to as test-taking skills. Such skills enable students to recognise what to do before-test, during-test, and after-test to achieve success (Bicak, 2013; Dodeen et al., 2014). As noted by Dixon and Erinosho (2020), "before-test skills include the study strategies prior to a test such as practicing past test / examination questions or self-quizzing; during-test skills are the strategies employed while taking a test which include time management, structure and organization, correctness of information, control of test anxiety and test-wiseness; whereas after-test skills include use of hints and feedback on test answers or scoring rubrics for managing future testing situation" (p. 4287). In their study that examined the interplay of test taking skills and performance in an open-ended mathematics test among secondary school students in Nigeria, Dixon and Erinosho (2020) found that test preparation comprising before, during and after test skills contributed significant positive variance to the prediction of students' performance on the tests.

PSLE Mathematics

The SEAB guide (SEAB, 2022) for the PSLE Mathematics outlines the format, content and assessment objectives of the examination.

The Format

PSLE Mathematics comprises two written papers, Paper 1 and Paper 2, that are taken at one sitting with an hour's break between them. Paper 1 is divided into two parts, Booklet A and Booklet B. Booklet A has fifteen multiple-choice questions while Booklet B has 15 short-answer questions. The use of calculators is not allowed for Paper 1 and students are expected to complete the paper within the one-hour allocated. Paper 2 consist of 5 short-answer questions and 12 structured questions. Calculators are allowed in Paper 2 and the duration for this paper is 1hour and 30mins. The allotment of marks for each paper is shown in Table 1.

The Content

The PSLE Mathematics covers three mathematics content strands, namely, i) Number and Algebra, ii) Measurement and Geometry, and iii) Statistics. The weightage of the strands and topics in the strands are shown in Table 2.

Assessment Objectives

The assessment objectives (AOs) for the PSLE Mathematics reflect the emphasis of the syllabuses and describe what students should know and be able to do with the concepts and skills learned in the syllabus. The AOs framed in three levels of increasing cognitive demand are: (i) AO1—recall mathematical facts, concepts, rules and formulae and perform straightforward computations, (ii) AO2—interpret information, understand and apply mathematical concepts and skills in a variety of contexts, and (iii) AO3—reason

mathematically; analyse information and make inferences; select appropriate strategies to solve problems. The weightage of the AOs in the PSLE mathematics papers is shown in Table 3.

The Study

The study adopted a qualitative research design involving a single case study approach (Creswell, 2007). It attempted to examine a specific aspect of out-of-school support for students preparing for the PSLE Mathematics. It used a purposeful survey to collect information about out-of-school PSLE Mathematics practice books and again purposeful sampling to carry out content analysis (Patton, 1990) of a sample of the practice books.

Object of Study

A survey of out-of-school PSLE mathematics practice books, available at the largest school bookstore in Singapore, was undertaken in December 2022. December is the month of the year when parents of students going on to Primary six in the following year are most active sourcing for resources to support their children's preparation for the PSLE Mathematics. During this period most practice books are available. We limited the scope of our survey. It excluded books that were wrapped and could not be examined by us, books with solution parts sold separately and any other book not specifically focused on PSLE Mathematics practice.

Data and Analysis

A total of 76 practice books were surveyed. Ten of the books had PSLE mathematics mock exams for timed practice only. Forty-nine of them comprised topical revision exercises and PSLE mathematics mock exams. Seventeen focused on problem solving strategies and solving of challenging problems. All the books had stepwise solutions provided. Thirty-nine had worked examples as part of the topical exercises and three had detailed marked scheme provided including examiners comments.

To answer the research question that guided the study reported in this paper, we limited our purposeful selection of the PSLE Mathematics practice books to those with mock exams only and those with topical revision exercises and mock exams. The rationale for this was that books in these two categories were most suited for the general preparation for the PSLE Mathematics. The books selected for study were:

- Lau & Yang (2018). Countdown to PSLE Maths Primary 6. Marshall Cavendish;
- Lee (2002). Mathematics weekly revision for Primary 6. Educational Publishing House Pte Ltd.

The first book: Countdown to PSLE Maths Primary 6, based on the 2018 PSLE examination guidelines and 2013 revised mathematics syllabus, comprises mock PSLE Mathematics exams. It has detailed marking schemes for self-assessment by learners. The second book, Mathematics weekly revision for Primary 6, was first published in 2011.The third edition (present one), published in 2018, is based on the 2018 PSLE examination guidelines and the 2013 revised mathematics syllabus. It comprises both topical revision exercises and mock PSLE exams.

To examine how the mathematics practice tasks in the mock PSLE Mathematics exams compared with the SEAB guide for PSLE Mathematics we analysed the first and last mock PSLE exams in the book Countdown to PSLE Maths Primary 6. There were 8 mock exams in the book and we purposively selected the first and last of these. As in all practices, easy questions precede difficult ones so as to allow the confidence of test takers to develop. In a similar manner we anticipated that the first and last mock exams would be the easiest and toughest respectively and allow us to see it's comparability with the SEAB guide for PSLE Mathematics.

The items in the mock exams were coded for type, content, and assessment objective. The papers were coded independently by the first author and a Primary 6 mathematics teacher for

type, content, and assessment objectives. There was 100% agreement for the type and content of all the test items. However, this was not the case for the assessment objectives, where the agreement was only 80%. For items where there were disagreements both the coders reviewed the codes during a meeting and mutually agreed on a code.

To study how the books facilitated test-taking preparation and test-taking skills we examined the organization and contents of the book: Mathematics weekly revision for Primary 6 (Lee, 2002).

Findings

How did the Mock PSLE Exams Compare With the SEAB Guide?

Table 1 shows that for Paper 1 the spread of the item types for the mock exams1 and 8 was similar. The number of items per item type and mark allocated was exactly as in the SEAB guide. However, for Paper 2 though the overall numbers per item type were as the SEAB guide, there was variation for the structured answer and long answer items. In mock exam 1, there were more long answer items compared to the structured answer items, while in mock exam 8, there were more structured answer items than the long answer items.

Table 1

Type and Mark of Mathematics Test Items in the Mock PSLE Exams 1 and 8

Paper	Type of test item	SEAB guide		Mock PSLE exams			
				Exam 1		Exam 8	
		No of items	Mark per question	No of items	Mark per question	No of items	Mark per question
1 (Booklet A)	MCQ	10	1	10	1	10	1
		5	2	5	2	5	2
1 (Booklet B)	Short answer	5	1	5	1	5	1
		10	2	10	2	10	2
2	Short answer	5	2	5	2	5	2
	Structured answer	12	3, 4 or 5	5	4, 5	8	3, 4, 5
	Long answer			7	3, 5	4	3
	Total	47	100	47	100	47	100

Table 2 shows that the spread of the strand and topics in the mock exams 1 and 8 were within a margin of ± 5% and consistent with the SEAB guidelines.

Table 3 shows that the spread of the assessment objectives for the mock exams 1 and 8 was skewed towards assessment objectives 2 and 3. The spread of assessment objectives in both mock exams was not consistent with the SEAB guidelines. Compared to mock exam 1, mock exam 8 was more challenging with 39% of the marks being allocated for test items with assessment objective 3, instead of 26%.

Table 2

Weightage of Topics in the SEAB Guide and Mock PSLE Exams 1 and 8

Strand	Topics	SEAB guide		Mock PSLE exams			
				Exam 1		Exam 8	
		%	Total %	%	Total %	%	Total %
Number and algebra	Whole numbers, fractions, decimals	25	45	27	46	32	49
	Ratio, percentage	10		9		10	
	Rate, speed	5		5		5	
	Algebra	5		5		2	
Measurement and geometry	Measurement	20	40	20	40	21	41
	Geometry	20		20		20	
Statistics	Statistics	15	15	14	14	10	10
Total		100	100	100	100	100	100

Table 3

Weightage of Assessment Objectives in the SEAB Guide and Mock PSLE Exams 1 and 8

Assessment objective	SEAB guide	Mock PSLE exams	
		Exam	Exam 8
	%	%	%
1	25	13	11
2	40	61	50
3	35	26	39
Total	100	100	100

A total of six items in the mock exams were inappropriate for PSLE mathematics. The first item required the students to draw on the concept of congruent triangles and find the area of a figure. The concept of congruent triangles is part of the secondary school mathematics curriculum and hence this item was beyond the mathematical knowledge of the students. The assessment objectives of the second, third and fourth items did not match the marks allocated for them. The fifth item tested a skill, drawing bar graphs, that was no longer in the PSLE mathematics syllabuses. The last and sixth item was a poorly constructed test item.

How did the Mock PSLE Exams Provide Support for Self-Assessment?

The mock PSLE exams provided students with support for self-assessment. For every practice the answer key for the multiple-choice questions, stepwise solutions for short answer questions and stepwise solutions together with mark schemes for questions 6–17 of paper 2 were provided. At times additional support in terms of explanations specific to a suggested strategy was also provided.

How was the Topical Revision PSLE Mathematics Practice Book Structured?

In tandem with the school calendar year, the topical revision book was organised into four terms. Each term was again organised into weeks. Terms 1, 2, and 3 had ten weeks each while term 4 had only 6 weeks.

How did the Content of the Topical Revision PSLE Mathematics Practice Book Support Test Preparation and Test-Taking Skills?

Table 4 shows the content of weekly practices for term 1. The weekly practices review essential concepts and skills tested during the PSLE Mathematics. In weeks 1, 2, and 3 the revision was focused on two or three topics each week. In week 4, the revision included all the topics worked through in weeks 1, 2, and 3. This provides students with an opportunity to revisit topics they did in the past weeks. This pattern of revising topics carries on for the first nine weeks. For all the nine weeks, the practices comprise of ten short answer questions and 4 structured / long answer questions. There are no multiple-choice questions. Also, no marks are allocated for any of the questions.

In week 10, students do a mock exam (Practice 10) that is modelled like the PSLE Mathematics comprising two papers. Paper 1 has two booklets, with booklet A comprising 15 multiple choice questions and booklet B comprising 15 short answer questions. Paper 2 has 17 questions, the first 5 are short answer questions and the next 12 are structured or long answer questions. The marks allocated for all the questions mirror PSLE Mathematics questions.

For term 2 (weeks 1–10) and term 3 (weeks 1–10) the practices are similar in structure with that of term 1. In term 4, there are only 6 weeks of practice. In week 1, there is revision comprising 10 short answer questions and 4 structured / long answer questions on topics that preceded term 4. The following five weeks provide students with opportunities to hone test-taking skills through timed mock PSLE mathematics exams.

Table 4

Content of Topical Revision PSLE Mathematics Practice Book for Term 1

Week	Content	Focus	Item types	Time
1 & 2	Whole numbers, Algebraic expressions	Revision of content	Section A–10 SAQ Section B–4 Str A / LA Q	No time limit
3	Solid figures, Nets, Volume of cuboids	Revision of content	Section A–10 SAQ Section B–4 Str A / LA Q	No time limit
4	*Revision* Whole numbers, Algebraic expressions, Solid figures, Nets, Volume of cuboids	Revision of content	Section A–10 SAQ Section B–4 Str A / LA Q	No time limit
5, 6 & 7	Fractions, Ratio	Revision of content	Section A–10 SAQ Section B–4 Str A / LA Q	No time limit
8	Whole numbers, Fractions, Ratio	Revision of content	Section A–10 SAQ Section B–4 Str A / LA Q	No time limit
9	*Revision* Whole numbers, Algebraic expressions, Solid figures, Nets, Volume of cuboids, Fractions, Ratio	Revision of content	Section A–10 SAQ Section B–4 Str A / LA Q	No time limit
10	*Term 1 Revision* Whole numbers, Algebraic expressions, Solid figures, Nets, Volume of cuboids, Fractions, Ratio	Test taking preparation and test-taking skills	Paper 1–Booklet A (15 MCQ) Booklet B (15 SAQ) Paper 2–5 SAQ, 12 Str / LA Q	Paper 1–1 hour Paper 2–1 hour 30 minutes

How did the Topical Revision PSLE Mathematics Practice Book Provide Support for Self-Assessment?

The support for self-assessment provided in the book was in the form of stepwise detailed solutions for both the topical practices and the mock PSLE mathematics practices. For the mock PSLE mathematics exams marks were also indicated at milestone steps.

Discussion and Conclusion

Past research suggests that learning may be enhanced through practice for examination preparation (Bord, 2008). Therefore, the two types of PSLE mathematics practice books examined as part of the study reported in this paper are critical in providing practice for the PSLE Mathematics. However, of concern is how closely do the practices in such books match the PSLE mathematics as outlined in the SEAB guide.

We found the mock exams 1 and 8 papers less adherent to the SEAB guide and past PSLE Mathematics papers. The test item types were according to the SEAB guide and of interest were the number of long answer items compared with the structured answer items. The SEAB guide just states that the total number of both type of items should be 12. In the mock exam 1, there were 5 structured answer and 7 long answer items and in the mock exam 8, there were 8 structured answer and 4 long answer items. The distribution of structured answer and long answer items in the mock PSLE Mathematics practice papers were not representative of the trend in the 2020 and 2021 PSLE Mathematics (see Teo, 2023), which is at most 3 long questions in paper 2.

The spread of the strand and topics in the mock exams 1 and 8 were generally consistent with the SEAB guide. The spread of the assessment objectives for both exams was not consistent with the SEAB guide. It is apparent from the spread that the items in the mock exams were more challenging than stipulated in the SEAB guide. In addition, there were several items in the mock exams that were inappropriate as they: were testing concepts in the secondary school mathematics curriculum; had a mismatch between assessment objective and mark allocated; were poorly constructed; had test objectives that were no longer in the PSLE Mathematics syllabuses. Otherwise, the mock exams were framed as per the PSLE Mathematics papers with time limits of papers just like the PSLE Mathematics.

Bearing in mind that the intent of such practices is to provide students with practise for a high-stakes examination like the PSLE, these books need to be representative of the examination in all aspects. Such practices do provide students with test-taking experiences that facilitate proficiency (Dixon & Erinosho, 2020).

Other than doing mock PSLE Mathematics exams, students preparing for the PSLE Mathematics may also need to engage with "before-test skills" which would include review of past knowledge (Bicak, 2013; Dodeen et al., 2014). In the book examined as part of the study reported here, i.e., Mathematics weekly revision for Primary 6, preparation for the PSLE mathematics was spread over the academic year and detailed by terms. There was emphasis on both mastery of content and test-taking skills. Mastery of content was through bite-sized exercises and development of test-taking skills was through periodic mock PSLE Mathematics exams that gradually extended the content coverage sequentially.

In both types of practice book the support provided by the books through worked solutions for the test items allowed the students to develop 'after-test' skills (Dixon & Erinosho, 2020). This involved using the stepwise solutions and mark schemes to engage in self-assessment and metacognitive activity to identify gaps in knowledge and remediate before doing more practice for the PSLE Mathematics. In conclusion, it is recommended that more studies be carried out on how students use such books for examination preparation. Teachers' perspectives of such

books would also be helpful for parents who may need resources to support their children's PSLE Mathematics preparation.

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