

Educational provision for less able students of English and Mathematics

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Introduction

Current plans to reform General Certificate of Secondary Education (GCSEs) in England and Wales include a return to linear assessment, the inclusion of more challenging course content, and an increase in demand at the level of what is widely considered to be a pass (Department for Education, 2013). Although these changes may help to stretch the most academically able 14 to 16 year olds, facilitating their progression to A levels and beyond, it is also important to ensure that secondary education caters for the full ability range. Students who struggle with core academic subjects also have a valuable contribution to make to society and the economy. Their educational achievements should be as significant a national concern as those of their more able peers.

In this article, we compare provision for equivalent students in four of the highest performing jurisdictions around the world: Singapore, New Zealand, Alberta (Canada) and Hong Kong¹. We also explore existing educational provision for less able 14 to 16 year old students of English and Mathematics in England. Although cultural and societal differences provide good reasons to discourage direct policy-borrowing (Crisp, 2014), international comparisons may nevertheless reveal some useful approaches for consideration.

Summary of provision in four high-performing jurisdictions

The main pathways through secondary education in the four high-performing jurisdictions considered in this article are summarised in Figure 1. England has also been included as a comparator. It can be seen that in all four jurisdictions, primary education ends a year later than in England. The point at which, and the extent to which, students are offered different curricula according to their abilities, both vary considerably.

Provision in Singapore

Singapore is a city-state with a population of approximately 5.3 million people (Ministry of Communications and Information, 2013). The Singaporean Ministry of Education is responsible for running state controlled schools and registering independent schools. It is also responsible for developing the school curriculum. Students attend primary schools from the ages of 7 to 12, and attend secondary schools from the ages of 13 to 16. Only primary school education is compulsory, but secondary education is universally available.

In Singapore, students are streamed² for the final two years of primary education and for the whole of secondary education. A streamed approach

was adopted to solve problems with high dropout rates due to the non-compulsory nature of secondary education, and to allow each student to progress at an appropriate rate (OECD, 2010). The lowest of the three secondary school streams – the Normal (Technical) stream – is for those students with the lowest scores in their end of primary school tests (approximately the bottom 15 per cent). The stream has a vocational focus with a practical teaching approach that is intended to prepare students for further technical and vocational training (Ismail and Tan, 2005).

The Normal (Technical) stream curriculum is designed to ensure that students are proficient in English, Mathematics and Computer Literacy. Students also study their mother tongue language and one or two non-compulsory subjects such as Science, Art, Food Studies, Mobile Robotics and Retail Operations (Singapore Examinations and Assessment Board, 2013). Curricula for all subjects are available from the Ministry of Education (2013) website. The Ministry is currently in the process of replacing the curricula for all secondary school students.

The aims of the post-2013 Normal (Technical) Mathematics curriculum are:

- to enable students who are bound for post-secondary vocational education to:*
 - acquire mathematical concepts and skills for real life, to support learning in other subjects, and to prepare for vocational education;*
 - develop thinking, reasoning, communication, application and metacognitive skills through a mathematical approach to problem solving; and*
 - build confidence in using Mathematics and appreciate its value in making informed decisions in real life.*

(Ministry of Education, 2012a).

The syllabus builds upon the content from the Foundation Mathematics syllabus which students have followed in primary school. The content is divided into five strands:

- i. three content strands:
 - a. Number and Algebra
 - b. Geometry and Measurement
 - c. Statistics and Probability
- ii. a context strand (Real World Context)
- iii. a process strand (a list of mathematical processes that can be found in the other four strands).

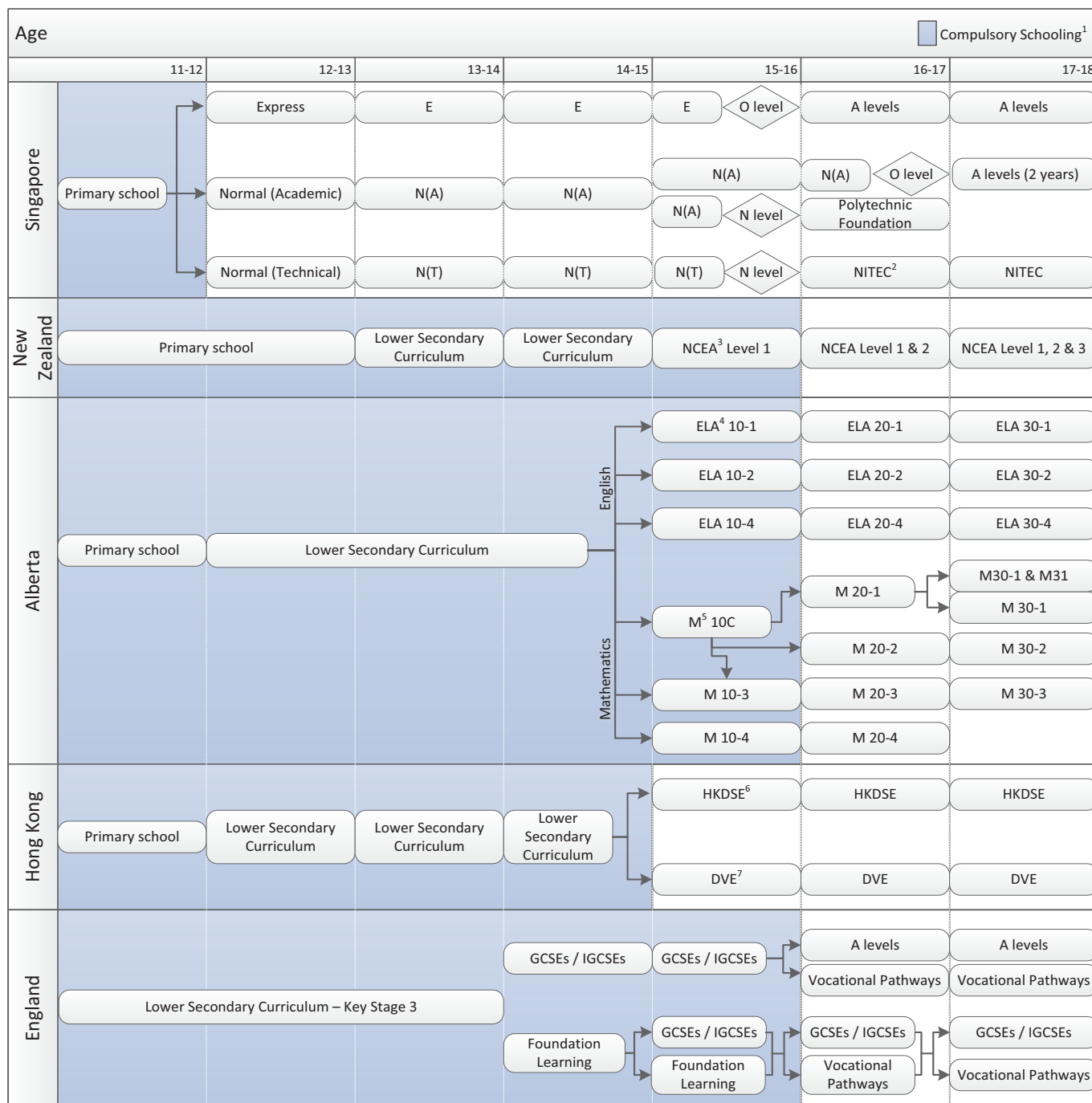
Within the curriculum the content is arranged by strand for each year group, and learning experiences are suggested alongside the content.

All students in the Normal (Technical) stream study English Language. There is no English Literature curriculum for Normal (Technical) stream students, although a few schools offer their own syllabuses as an elective module. There are three aims in the current English Language syllabus, which are intended to result in functional fluency in English:

1. These jurisdictions are considered to be high-performing because they have achieved high scores in recent PISA, TIMSS and PIRLS tests.

2. In this article, streaming is defined as grouping students by ability across all subjects, whereas setting is defined as grouping students by ability for particular subjects.

Figure 1: Pathways through secondary education in four high-performing jurisdictions



1 Note that for England only, compulsory schooling is different from compulsory education. Students can leave school at 16, but they must continue some form of compulsory education until they are 17 (this will be raised to 18 from September 2014). Compulsory education can be an apprenticeship, or full-time employment combined with part-time education/training as well as schooling.

2 NITEC = National Institute of Technical Education Certificate

3 NCEA = National Certificate of Educational Achievement

4 ELA = English Language Arts

5 M = Mathematics

6 HKDSE = Hong Kong Diploma of Secondary Education

7 DVE = Diploma in Vocational Education

1. Listen, read and view³ critically and with accuracy and understanding a wide range of literary and informational/functional texts from print and non-print sources
2. Speak, write and represent³ in internationally acceptable English (Standard English) that is grammatical, fluent, mutually intelligible and appropriate for different purposes, audiences, contexts and cultures

3. Understand and use internationally acceptable English (Standard English) grammar and vocabulary accurately and appropriately as well as understand how speakers/writers put words together and use language to communicate meaning. (Ministry of Education, 2010, p.10).

The syllabus is divided up into six areas of language learning:

- i. Listening and viewing
- ii. Reading and viewing
- iii. Speaking and representing
- iv. Writing and representing

3. "The skills of Viewing and Representing are integrated with Listening, Reading, Speaking and Writing to take into account the importance of developing information, media and visual literacy skills in the teaching and learning of English Language". (Ministry of Education, 2010).

- v. Grammar
- vi. Vocabulary.

Each area of learning is divided into focus areas with associated learning outcomes. The skills, strategies, attitudes and behaviours required for each focus area are listed in the syllabus, and the year groups they apply to (from Primary 5 through to Secondary 4) are identified, thereby showing the progression in skills that are acquired. Within all of the focus areas, students study the use of English in a wide range of texts, including spoken and visual texts (e.g. songs, media programmes, and online texts).

At the end of the Secondary 4 Year, Normal (Technical) stream students sit N(T)-Level examinations. Most subjects are jointly examined by the Ministry of Education and Cambridge International Examinations. Students are assessed via written and practical examinations. In Languages (both English and Mother Tongue) students are also assessed by oral examinations and listening comprehensions. There are five grades: grades A to D (considered to be a pass) and Ungraded. The Normal (Technical) Level Certificate is awarded to all candidates who achieve a pass in one or more subjects. In 2012 it was awarded to 98.1 per cent of the Normal (Technical) students (Ministry of Education, 2012b).

Provision in New Zealand

New Zealand is an island country with a population of approximately 4.5 million people (Statistics New Zealand Tatauranga Aotearoa, 2013). The Ministry of Education oversees the whole education system, and develops the curriculum and the national assessment standards. The New Zealand Qualifications Authority (NZQA) is responsible for: managing the New Zealand Qualifications Framework, administering the secondary school assessment system, recognising qualifications and setting the standards for some unit standards.

Education in New Zealand is compulsory from the ages of 6 to 16. Primary education runs from the ages of 5 to 13 (Years 1 to 8) and secondary education runs from 13 to 18 (Years 9 to 13). There are many different types of schools in the country. The main differences between them are in the age ranges they cater for, whether they are state or independent schools, and whether or not they are Māori schools. Almost all schools accept students of all abilities. Students tend not to be required to repeat years, or to be streamed (although they may be set for particular subjects within their schools).

The New Zealand National Curriculum is followed by all students in New Zealand from Year 1 to Year 13. The content is shown by subject, and within each subject the content is divided into eight levels. Each level covers several year groups, and each year group is expected to be working at two or more levels. As well as English, and Mathematics and Statistics, students must study the Arts, Health and Physical Education, Science, the Social Sciences, and Technology until the end of Year 10.

From Year 11 to Year 13, students work towards National Certificates of Educational Achievement (NCEAs). These certificates were designed to "recognise and credential the learning success of all students, whatever their traditional academic prowess." (Hipkins, 2013, p.19). The NCEAs are available at three levels: Level 1, Level 2, and Level 3. Students are expected to achieve a Level 1 Certificate in Year 11, Level 2 in Year 12 and Level 3 in Year 13. However, the content is not tied to particular academic years. At each level, students are able to study some content at the level below. Students can also take more than a year to cover the content, which means that low performers are able to take more than one year to complete each level of their NCEAs (New Zealand Qualifications Authority, 2013a).

The NCEA subjects are divided into many individual 'standards' (units), each of which targets a specific skill and is aligned to one of the three levels. Students are able to study a subject at more than one level, for example taking History standards at Level 1 and Level 2 during the same school year. Each standard is worth a certain number of credits, with each credit worth approximately ten hours of study. Generally, courses that students follow are worth 18 to 24 credits, although some courses only contain 12 credits and others contain more than 30. To achieve an NCEA certificate, students have to achieve 80 or more credits, of which at least 60 have to be of that level or above. In addition, for the Level 1 NCEA, students must achieve ten of these credits for Level 1 Numeracy and ten for Level 1 Literacy. The standards containing the literacy and numeracy requirements occur in a range of subjects, not just in English, Mathematics, and Statistics.

There are two types of standards: *achievement* standards and *unit* standards. *Unit* standards are based on competency and are usually graded A (achieved) or N (not achieved). They are all assessed internally through the accumulation of evidence. *Achievement* standards are based on the New Zealand curriculum and are graded A (achieved), M (merit), E (excellence) or N (not achieved). Those with content that cannot be tested in an exam (e.g. research projects or speaking) are assessed internally; other achievement standards are assessed externally, usually at the end of the school year.

Students can also take National Certificates (New Zealand Qualifications Authority, 2013b). These qualifications are available in a range of school-related areas and are intended to prepare students for further learning or for a related line of employment. Many of the National Certificates are available in subjects related to particular professions (e.g. the National Certificate in Hospitality, the National Certificate in Building, Construction, and Allied Trades Skills) and most of these are only available at Levels 2 and 3; however, there are also National Certificates in Mathematics available at Levels 1 and 2 (*ibid*). No National Certificate exists specifically for English or Literacy, but literacy skills are covered within some of the National Certificates (e.g. the National Certificate in Employment Skills).

Provision in Alberta, Canada

The province of Alberta in Western Canada is approximately 2.5 times the size of the UK but has a population of only 4 million people (Alberta Government, 2013). Typically, students in Alberta attend a junior high school from Year 7 until the end of Year 9. At the end of Year 9, they sit provincial achievement tests in 'English Language Arts', Mathematics, Science and Social Studies. The tests provide information about students' achievements and facilitate comparisons across the province. Teachers use the test results to reflect on and improve their teaching, as well as to report levels of achievement to students and parents (Alberta Education, 2013a).

Subsequently, most students transfer to a senior high school for Years 10, 11 and 12. Of these final three school years, Year 11 is often considered the most stable and productive year for students. This is because in Year 10 they are finding their feet, and in Year 12 they have the stress and excitement of graduating (attending various festivities), and of applying to university and for other educational or employment opportunities (Alberta Learning, 2003a).

At senior high schools, many courses have a '10–20–30' structure. This means that students typically complete the '10' course in Year 10, the '20' course in Year 11, and the '30' course in Year 12. For particular

subjects, including English Language Arts and Mathematics, alternative courses with differing content and difficulty are available to students. The course that a student follows will depend upon his or her career and educational aspirations, achievements in the Year 9 provincial achievement tests, and teacher advice (Alberta Learning, 2003b). The start of Year 10 is therefore a key point of divergence into different educational pathways.

The Albertan education system does not aim to get all students to the same point of learning by the time they leave high school. Instead, a key feature of the system is its 'knowledge and employability' courses, which are available in core subjects (including English and Mathematics) from Year 8 to Year 12 inclusive. These courses offer an important educational pathway for less academically able students, but are not designed for students with special education needs. They are:

... intended to provide students with opportunities to experience success and become well prepared for employment, further studies, active citizenship and lifelong learning. Knowledge and Employability courses include and promote:

- *workplace standards for academic, occupational and employability skills*
- *practical applications through on- and off-campus experiences and/or community partnerships*
- *career development skills for exploring careers, assessing career skills and developing a career-focused portfolio*
- *interpersonal skills to ensure respect, support and cooperation with others at home, in the community and at the workplace.*

(Government of Alberta, 2009, p.3).

Enrolment in one or more knowledge and employability courses is determined individually on a course-by-course basis. The decision is based on each student's achievements and goals, and how those goals relate to the philosophy, rationale and intent of the courses. Students are assessed by their teachers. They aim to achieve a Certificate of High School Achievement (Knowledge and Employability), rather than the Alberta High School Diploma which is obtained by the most able students. It is intended that students who achieve the certificate will progress to employment, further training and courses, or other opportunities not requiring post-secondary education (*ibid*).

The Knowledge and Employability course in 'English Language Arts' is targeted at students who have experienced challenges or difficulty with their skills such that they have a grade level achievement two to three years below their more able peers. The course aims to show students additional strategies for success in English. Course materials tend to have practical applications and are designed to support development of reading comprehension, communication, and other occupational skills, such as creating brief texts (Alberta Learning, 2003b). Similarly, the Knowledge and Employability course in Mathematics is targeted at students who have a grade level achievement in Mathematics two to three years below their peers. It includes topics such as number, shape and space, patterns and relations, and statistics and probability (Alberta Education 2013b).

Provision in Hong Kong

Hong Kong is a specialist administrative region in China with a population of approximately 7.2 million (GovHK, 2013). It is autonomous from China in all areas except defence and foreign affairs. The education system is run by the Bureau of Education. Schooling is

compulsory from the ages of 6 to 15. Primary education runs from the ages of 6 to 12. Secondary schooling starts at age 12 and continues until age 18.

Until 2011, the structure of secondary education in Hong Kong was similar to that in some parts of England. Junior secondary education lasted for three years. After a further two years of education, students took the Hong Kong Certificate of Education Examination (approximately equivalent to O levels). Another two years of study led to the Hong Kong Advanced Level Examination (approximately equivalent to A levels). In 2012, the Hong Kong Certificate of Education Examination and the Hong Kong Advanced Level Examination were replaced by a single form of certification, the Hong Kong Diploma of Secondary Education Examinations (HKDSE), which is obtained at the end of secondary education (at age 18). Assessment for the HKDSE is a combination of public examinations and moderated school-based assessments.

Although the three years of senior secondary education (ages 15 to 18) are optional, it is expected that all students will continue their education through this stage (Hong Kong Examinations and Assessment Authority, 2013). There are no academic requirements for entry to senior secondary education, but within individual schools, places may be allocated on the basis of academic performance. Working towards the HKDSE, senior secondary students study four core subjects: Chinese Language, English Language, Mathematics and Liberal Studies. They are also expected to choose two or three elective subjects. These may include science subjects, languages and applied subjects such as Engineering and Production.

Whilst senior secondary students can study all subjects regardless of their ability level, there is some differentiation of subject content for students of differing abilities. In Mathematics, the core (compulsory) curriculum is divided into three strands: Number and Algebra; Measures, Shape and Space; and Data Handling (Curriculum Development Council and Hong Kong Examinations and Assessment Authority, 2007a). Each of these strands contains foundation and non-foundation topics. These are assessed in separate parts of the two HKDSE examination papers that students take at the end of their courses (alongside moderated school-based assessments). The foundation topics are intended to provide all students, including those who are less able, with coherent knowledge of the essential concepts and knowledge within Mathematics. Less able students may study only the foundation topics, or may study the foundation topics plus some of the non-foundation topics. More able students can also choose to study additional content in one of two optional units: Calculus and Statistics or Algebra and Calculus (*ibid*).

The English curriculum is not divided up as formally. There is a compulsory part of the curriculum which lasts three years (Curriculum Development Council and Hong Kong Examinations and Assessment Authority, 2007b). In the second and third of these years, students also study three elective modules, from a choice of eight modules. There is no official reduction in the curriculum content for lower ability students, but teachers are advised that the curriculum can be adapted and reduced for these students (*ibid*).

The curriculum is organised into three strands, which state the reasons for learning English. The 'interpersonal' strand is about interpersonal communication. The 'knowledge' strand allows students to develop and apply knowledge. Finally, the 'experience' strand requires students to respond and express real and imagined experiences. In addition to the three strands, generic skills and values and attitudes are also key components of the English curriculum (*ibid*).

Table 1: Key features of secondary education in four high performing jurisdictions

	England	Singapore	New Zealand	Alberta	Hong Kong
All students aim to get to the same level?	No	No	No	No	Yes
% repeating school years⁴	2.2%	5.4%	5.1%	Canada: 8.4%	15.6%
Provision for less able	Either same qualifications with some higher level content omitted or different qualifications	Different courses and qualifications. Low ability students in Normal (Technical) stream [N(T)]	Low ability students move through curriculum at own rate and work on a lower level standards (units)	Different courses and qualifications with different content and focus. Low ability students follow Knowledge and Employability courses	Same qualifications. Low ability students omit some curriculum content
School structure	Varies	Comprehensive, with streaming within schools	Fully comprehensive	Comprehensive	Unknown
Typical age at which separated	Varies by school	12	Unknown	15, or sometimes earlier, e.g. 13	Unknown
Method of separation	Mathematics and English usually set by ability	Streamed across all subjects	Mathematics and English usually set by ability	Mathematics and English usually set by ability	Unknown. Assume setting within subjects
Basis for separation	Varies, depending on when students are set by ability. Key Stage 2 test results, or internal school tests may be used	Primary school leaving exam results	Unknown	Year 9 assessments or teacher evaluation. Weakest students may sometimes be separated after teacher evaluation at the end of Year 7	Unknown
Movement between pathways	No set pathway	Students transfer out of N(T) stream to the Normal (Academic) stream if they meet the criteria	No set pathway. Students study individual standards at appropriate pace	Students can move between adjacent pathways but this may entail an extra year of study	N/A
English curriculum	Content of GCSE specifications is the same for students of all abilities. Low ability students take foundation tier examinations	Separate curriculum for all three pathways. N(T) students only study English Language	Curriculum split into standards at three levels.	Three main pathways, each with own curriculum	Same curriculum for all students. Teachers adapt curriculum for lower ability students
Mathematics curriculum	GCSE specifications are split into foundation and higher tier content. Low ability students take foundation tier content and examinations	Separate curriculum for all three pathways	Curriculum split into standards at three levels	Four main pathways, each with own curriculum	Compulsory content split into foundation and non-foundation topics. Low ability not taught (all) foundation topics
Qualifications at 16 (or end of secondary school if no intermediate exam)	Most students take GCSEs; low ability students take them at foundation level. Some low ability students take other Level 1 qualifications instead	Exams taken at approximately age 16. High ability take O levels; middle take O level and N(A) level; low ability take N(T) level	NCEA subjects taken at 3 different levels, depending on ability	High and middle ability take Alberta High School Diploma (age 18). Low achievers obtain Certificate of High School Achievement (Knowledge and Employability)	Exams at end of senior secondary only, age 18. All learners take same exam (HKDSE)
Type of assessment	External	External	Combination of external and school-based assessment	Alberta High School Diploma: combination of external and school awarded mark. Certificate of High School Achievement: teacher assessed	Combination of external examinations and moderated school-based assessment

4. Taken from PISA data for the number of students repeating one or more grades (PISA, 2009)

Assessment for the English Language part of the HKDSE comprises public examination papers for:

- i reading
- ii writing
- iii listening and integrated skills
- iv speaking.

(Curriculum Development Council and Hong Kong Examinations and Assessment Authority, 2013).

Additionally, for school candidates there is a school-based assessment component which aims to encourage extensive reading and viewing. The reading paper and the listening and integrated skills paper each contain three sections. In each case, the first section is compulsory, then candidates can choose between the second (easiest) and third (hardest) sections. Whilst the second section other assesses only the lowest four grades, the third section assesses the whole range of grades (Curriculum Development Council and Hong Kong Examinations and Assessment Authority, 2007b).

Comparison with provision in England

England has a population of 53.5 million people (Office for National Statistics, 2013), which is considerably greater than the populations of the other jurisdictions considered in this article. In England a wide range of courses and qualifications are available for 14 to 16 year olds. Some less able students are offered extra support in taking mainstream general qualifications in English and Mathematics, such as GCSEs, alongside more able students. Others follow a 'foundation learning' pathway in which they may be offered formal qualifications at lower levels, often focusing on core or functional skills.

Foundation learning is aimed at the weakest 20–25 per cent of learners, including those with special educational needs, those who are at risk of disengagement, and those with 'spiky' attainment profiles (Department for Children, Schools and Families, 2010). Whilst students are significantly more likely to be male than female, gender is not a basis for allocation to a foundation learning pathway. Instead, selection is based upon students having achieved significantly below the national average at Key Stage 3 (at age 14) and/or having particular behavioural characteristics (Allan, *et al.*, 2010). Students are usually expected to progress to GCSEs or to a vocational educational pathway such as a traineeship or an apprenticeship, although some may move on to supported employment or independent living pathways.

Foundation learning is intended to support the aims of the National Curriculum for Key Stage 4. For each individual, a personalised programme is developed, which is tailored to his or her particular needs, interests and aspirations. Programmes incorporate three key components:

- i. vocational/subject learning;
- ii. personal and social development; and
- iii. functional skills (in English, Mathematics, and ICT).

The choice of component units and qualifications, including the level and size of those qualifications, should be matched to the student's intended destination.

Although stand-alone functional skills qualifications are available, many non-selective secondary schools opt for their lower ability students to follow GCSE or International (I)GCSE courses in English and Mathematics (which have functional skills integrated within them) as part of their foundation learning pathways. A possible reason for this may be that GCSEs and IGCSEs are perceived to have a greater currency, even at low grades. Some schools enter their least able students for Entry level qualifications instead of, or as well as, GCSEs.

Summary

Further key features of the four high-performing jurisdictions described above are summarised in Table 1, alongside features of the English system. It can be concluded that provision for less able students of English and Mathematics varies considerably both within and across countries. Three of the four high-performing jurisdictions considered in this investigation provide courses specifically for such students, as does England. In Alberta and Singapore, courses for the least able focus on knowledge and skills which will have a practical value in the workplace, rather than on preparing students for higher level academic study in English and Mathematics.

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Common errors in Mathematics

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Background

When answering Mathematics questions, students often make errors leading to incorrect answers or the loss of accuracy marks. Many of these errors will be random, occurring through calculation errors or misreading of the question, and will not affect many candidates. However, some errors may be seen in a number of students' scripts. These are sometimes referred to as common errors.

At the end of each examination session, an examiners' report is produced for centres. These reports are intended to enable teachers to better prepare their students for future examinations (OCR, 2012). The precise content of these reports varies depending on the subject and awarding organisation, but all generally contain a commentary on the way that students answered the questions. In Mathematics this commentary may refer to the methods that students used to answer the question, but it often also includes details about the common errors that were made by students.

There is a debate in the literature about the difference between errors and misconceptions. Confrey (1990) defines both errors and misconceptions as resulting from the rules and beliefs that students hold, but suggests that the difference is that misconceptions are attached to particular theoretical positions. However, other researchers, such as

Nesher (1987), use the term misconceptions to describe systematic errors without reference to a theoretical position. Further researchers, such as VanLehn (1982, in Confrey, 1990) and Brown and Burton (1978, in Dickson *et al.*, 1984), use a further term, 'bug', to describe those errors that arise from wrong steps in a calculation procedure.

There is a body of research literature that identifies misconceptions in students' mathematical understandings. For example, Swan (1990) described two sets of misconceptions held by students: those that affected their calculations using the four operations (addition, subtraction, multiplication and division); and those affecting their interpretation of graphs. Other researchers have investigated misconceptions that occur in algebra (e.g. Brown & Burton, 1978). However, many of these studies were carried out in the 1970s and 1980s, and the misconceptions that were identified then may not be as relevant today. Changes to the content of specifications, or the way that Mathematics is taught may have affected the errors that students make, and there may now be previously unidentified misconceptions as a result.

The aim of this study was to identify common errors that have been made in Mathematics exams. It examined all the common errors that students made, regardless of whether they were systematic errors, bugs or slips, as all types could provide useful information for teachers and examiners. It focussed on the General Certificate of Secondary Education