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Quality Council for General and Further Education and Training

International Benchmarking of the South African National Senior Certificate (NSC) Subject Findings Appendix: Mathematics

20th Anniversary

Two Decades of Education Guardianship
2002 - 2022

International Benchmarking of the South African National Senior Certificate (NSC) Subject Findings Appendix: Mathematics

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Introduction

Overview of NSC Mathematics

Mathematics is a compulsory subject area in the NSC. In the Academic (General) pathway, students must offer four subjects from Group A, to include either Mathematics or Mathematical Literacy. Ecctis has analysed only the curriculum information for Mathematics (not Mathematical Literacy). Students offering NSC Physical Sciences are required to take Mathematics as a compulsory subject. All NSC Mathematics curricula are intended to develop a functioning knowledge of the subject, including their competences in mathematical reasoning. This is intended as preparation for more abstract mathematics in subsequent education or career paths.[1]

Structure of Appendix

This subject comparison appendix addresses the relationship between NSC Mathematics and subjects which fulfil similar roles in five alternative programmes. This appendix is structured to first demonstrate points of comparability and contrasts between the subjects (under the subheading Comparison) and then to synthesise this into Key Findings with a particular focus on skill development. This analysis examines all comparison subjects against NSC Mathematics simultaneously, to enable stakeholders to see the range of similarities and differences across the international contexts in a single place. The analysis is based on the review of the NSC Mathematics curriculum and assessment documentation for grades 10 to 12, and more specifically on the 2011 Curriculum and Assessment Policy Statement for Mathematics and the 2017 Examination Guidelines and the 2020 Marking Guidelines for Mathematics.

[1] National Curriculum Statement (NCS) (2011), *Curriculum and Assessment Policy Statement Grades 10-12 Mathematics*, p. 10.

Comparison

Subjects in Context

A single Mathematics programme from Cambridge International AS/A Level is used for comparison, this subject is non-compulsory within the wider programme. Cambridge International Mathematics covers a large range of core mathematics topics referred to as "pure mathematics". Core mathematics, in this report, is a phrase used to differentiate content that is statistical, mechanical, or "core" (i.e. general mathematics that does not fall into either prior category).

In some programmes, optional topics are offered which focus in depth on mechanics, statistics, and decision mathematics. A Further Mathematics International A Level is also offered by Cambridge International; that curriculum was not analysed here.

The IB Diploma Programme offers multiple Mathematics curricula. From 2021 onwards, new Mathematics curricula have been developed which are called Mathematics: Analysis and Approaches (available at Higher Level and Standard Level) and Mathematics: Applications and Interpretation (available at Higher Level and Standard Level). However, in this report Ecctis have used the generation of Mathematics curricula which were used up to 2021 (as a priority was placed by Umalusi on comparison with subjects which have already completed a full teaching and assessment cycle). The IB DP Mathematics curricula available up to 2021 were Further Mathematics (Higher Level only), Mathematical Studies (Standard Level only) and Mathematics (available at Higher Level and Standard Level). Ecctis has considered the IB DP Mathematics curriculum at both Higher and Standard level. Mathematics is a compulsory subject in order to be awarded the IB Diploma; however, students get the choice as to which level they would like to study. The HL requires an additional 100 guided learning hours and covers several more topics.

The NSW HSC has five different Mathematics curricula: Advanced Level, Standard 1, Standard 2, Extension 1 and Extension 2 – all of which are non-compulsory. Standard 1 and 2 are very similar with small variations in the content regarding the sub-topics. Extensions 1 and 2 cover additional mathematics topics that would not be included in core mathematics. In order to provide as much breadth and perspective as possible on relevant comparisons with the NSC Mathematics curriculum, Ecctis has elected to include Standard 1 and 2 as well as Advanced. Advanced Mathematics differs from Standard level as it covers a greater quantity and variety of mathematics topics.

KCSE Mathematics is a compulsory subject for students to obtain the KCSE certificate. Two options are offered: KCSE Mathematics A and KCSE Mathematics B. Only KCSE Mathematics A has been used as a comparison point for this analysis as preliminary analysis suggested that Mathematics A is taken by a larger number of students in the KCSE system and is the more valuable comparison point for the NSC curricula in question.

Ecctis has also included ZIMSEC Pure Mathematics Forms 5-6. This subject articulates aims such as enabling communication of mathematical ideas and information as well as developing a positive attitude towards this subject area and enhancing "the ability to investigate and interpret numerical and spatial relationships as well as patterns that exist in mathematics and in the world in general".[2]

[2] Zimbabwe Ministry of Primary and Secondary Education (2015), *Pure Mathematics Syllabus Forms 5-6*, p. 1.

Entry Requirements, Duration, Mode of Study, Progression Routes

The table below summarises any entry requirements for each subject, the duration of study within the programme, the mode of study, and any notable facts about progression routes which study of each subject enables either nationally or internationally.

Table 1: Comparison of subject-specific entry requirements, expected prior learning, duration of study and recommended progression routes

	Subject-Specific Entry Requirements	Expected Prior Learning	Duration of Study	Recommended Progression Routes
NSC Mathematics[3]	For Grade 10: • An official Grade 9 school report which indicates that a learner has met the requirements for promotion to Grade 10 or; • a General Education and Training Certificate (GETC) for Adult Basic Education and Training (ABET); or • a NQF Level 1 Certificate which requires two languages; or • a recognised equivalent qualification obtained at NQF Level 1 which requires two official languages. • an official document of approval from the relevant Head of Education confirming that a learner who has received home education prior to Grade 10 has reached the required level in Grade 9. For Grades 11 and 12: • For Entrance into Grades 11 and 12, an appropriate statement of achievement at the appropriate levels is issued by an approved or recognised assessment body. All learners are taught Mathematics in the lower grades (Grade R – 9). A minimum mark of 30% is required for a learner to offer Mathematics in Grade 10.	No assumed learning required stated in subject documentation.	3-year programme (Grades 10-12) which requires 4.5 guided learning hours per week	Subject curriculum documentation states that "The subject Mathematics in the Further education and Training Phase forges the link between the Senior Phase and the Higher/ Tertiary education band. All learners passing through this phase acquire a functioning knowledge of the Mathematics that empowers them to make sense of society. It ensures access to an extended study of the mathematical sciences and a variety of career paths. In the FET Phase, learners should be exposed to mathematical experiences that give them many opportunities to develop their mathematical reasoning and creative skills in preparation for more abstract mathematics in Higher/Tertiary education institutions".

[3] National Curriculum Statement (NCS) (2011), *Curriculum and Assessment Policy Statement Grades 10-12 Mathematics*, p. 10; Department of Basic Education, Republic of South Africa (2021), *National Policy Pertaining to the Programme and Promotion Requirements of the National Curriculum Statement. Grades R-12*, pp. 29-30.

	Subject-Specific Entry Requirements	Expected Prior Learning	Duration of Study	Recommended Progression Routes
IB DP Mathematics (SL)[4]	Schools will engage with students' educational backgrounds on an individual basis	Subject documentation names specific subtopics that students will be expected to have prior awareness of, within each of the following topic areas • Number • Sets and numbers • Algebra • Trigonometry • Geometry • Coordinate Geometry • Statistics and probability	2-year programme, aimed for students between the ages of 16 and 19. The IB recommends 150 teaching hours. 10 hours will be spent on work for the exploration (Internal assessment).	Subject documentation describes the design of the subject in relation to the following possible progression: "The majority of these students will expect to need a sound mathematical background as they prepare for future studies in subjects such as chemistry, economics, psychology and business administration".
IB DP Mathematics (HL)[5]	Schools will engage with students' educational backgrounds on an individual basis	Subject documentation states that "Students will have a wide variety of skills and knowledge when they start the Mathematics HL course. Most will have some background in arithmetic, algebra, geometry, trigonometry, probability and statistics. Some will be familiar with an inquiry approach, and may have had an opportunity to complete an extended piece of work in mathematics".	2-year programme, aimed towards students between the ages of 16 and 19. The IB recommends 240 teaching hours. 10 hours will be spent on work for the exploration (Internal assessment).	Subject documentation describes the design of the subject in relation to the following possible progression: "The majority of these students will be expecting to include mathematics as a major component of their university studies, either as a subject in its own right or within courses such as physics, engineering and technology."

[4] International Baccalaureate (2012), *Diploma Programme: Mathematics Standard Level (SL) Guide*, p. 5.

[5] International Baccalaureate (2012), *Diploma Programme: Mathematics Higher Level (HL) Guide*, p. 6.

	Subject-Specific Entry Requirements	Expected Prior Learning	Duration of Study	Recommended Progression Routes
Cambridge International AS/A Level Mathematics[6]	Schools will engage with students' educational backgrounds on an individual basis.	Subject documentation states that "Knowledge of the content of the Cambridge IGCSE® Mathematics 0580 (Extended curriculum), or Cambridge International O Level (4024/4029), is assumed."	2-year programme, 180 guided learning hours recommended for each Cambridge International AS Level. 360 guided learning hours for a Cambridge International A Level (Approximately 4.6 guided learning hours per week).	Subject documentation describes the following features of design and how they related to intended progression routes: "Cambridge International AS & A Level Mathematics aims to develop a set of transferable skills. These include the skill of working with mathematical information, as well as the ability to think logically and independently, consider accuracy, model situations mathematically, analyse results and reflect on findings. Learners can apply these skills across a wide range of subjects and the skills equip them well for progression to higher education or directly into employment".
KCSE Mathematics A[7]	School candidates must be holders of KCPE Certificate or its equivalent. Prospective candidates with foreign certificates must seek equation of the foreign certificates before being admitted into the Kenyan schools.	No assumed learning stated in subject documentation.	4 years of study.	Students who scored an aggregate of C+ grade and above will be selected for the degree placement procedure, in both private and public universities, and their degree will be sponsored by the government.

6 Cambridge International Examinations (2016), *AS and A Level 2016: Syllabus: Cambridge International AS and A Level Mathematics 9709*, pp. 3,11.

7 The Kenya National Examinations Council (2014), *Kenya Certificate of Secondary Education (KCSE): Examinations Regulations and Syllabuses.*

	Subject-Specific Entry Requirements	Expected Prior Learning	Duration of Study	Recommended Progression Routes
ZIMSEC Forms 5-6 Pure Mathematics[8]	No subject-specific entry requirements are mentioned in the qualification documents.	"The syllabus assumes that the learner has: • passed at least one of the following at form 4: Mathematics, Pure Mathematics and Additional Mathematics • interest in studying Pure Mathematics form 5 – 6".	2-year programme. 10 periods of 35 minutes each per week should be allocated (5.8 hours per week).	Subject documentation articulates the following aspects of curriculum design in relation to intended progression routes: "Pure Mathematics is developed to provide continuity of pure mathematical concepts and lay foundations for further studies. The two-year learning phase will provide learners with opportunities to apply pure mathematical concepts, principles and skills in other learning areas".
NSW HSC Advanced Mathematics[9]	Prerequisites: The Mathematics Advanced Year 11 course has been developed on the assumption that students have studied the content and achieved the outcomes of the Mathematics Years 7–10 Syllabus and in particular, the content and outcomes of all substrands of Stage 5.1 and Stage 5.2, and some substrands of Stage 5.3.	See prerequisites (left). A full list of relevant topics is provided online, including: • Algebraic techniques • Surds and indices • Equations • Linear relationships • Trigonometry and Pythagoras' theorem • Single variable data analysis • Non-linear relationships • Properties of Geometrical Shapes.	2-year course targeted at year groups 11 and 12. Total time allocation of 120 hours per year.	Awarding body documentation claims that: "Advanced Mathematics is designed for those students whose future pathways may involve mathematics and its applications in a range of disciplines at the tertiary level".

[8] Zimbabwe Ministry of Primary and Secondary Education (2015), *Pure Mathematics Syllabus Forms 5-6*, p. 1.

[9] New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Advanced Stage 6 Syllabus.*

	Subject-Specific Entry Requirements	Expected Prior Learning	Duration of Study	Recommended Progression Routes
NSW HSC Standard 1 Mathematics[10]	Prerequisites: Students have studied the content and achieved the outcomes of the *Mathematics Years 7–10 Syllabus* and, in particular, the content and outcomes of all substrands of Stage 5.1 and several substrands of Stage 5.2.	See prerequisites (left). A full list of relevant topics is provided online, including: • Area and surface area • Financial mathematics • Linear relationships • Non-linear relationships • Right-angled triangles (Trigonometry) • Single variable data analysis • Volume • some content from Equations • some content from Probability.	2-year course targeted at year groups 11 and 12. Total time allocation of 120 hours per year.	Awarding body documentation claims that: "Mathematics Standard 1 aims to provide an appropriate mathematical background for students entering the workforce and/or undertaking further community and workplace training".
NSW HSC Standard 2 Mathematics[11]	Prerequisites: Students have studied the content and achieved the outcomes of the *Mathematics Years 7–10 Syllabus* and, in particular, the content and outcomes of all substrands of Stage 5.1 and several substrands of Stage 5.2.	See prerequisites (left). A full list of relevant topics is provided online, including: • Area and surface area • Financial mathematics • Linear relationships • Non-linear relationships • Right-angled triangles (Trigonometry) • Single variable data analysis • Volume • some content from Equations • some content from Probability.	2-year course targeted at year groups 11 and 12. Total time allocation of 120 hours per year.	Awarding body documentation claims that: "Mathematics Standard 2 aims to provide an appropriate mathematical background for students entering the workforce and prepares students for a wide range of educational and employment aspirations, including continuing their studies at a tertiary level".

[10] Ibid

[11] Ibid

NSC Mathematics covers a period of 3 years (grades 10-12). The entry requirements for Grade 10 include an official Grade 9 school report which indicates that a learner has met the requirements for promotion to Grade 10 or; a General Education and Training Certificate (GETC) for Adult Basic Education and Training (ABET); or a NQF Level 1 Certificate which requires two languages; or a recognised equivalent qualification obtained at NQF Level 1 which requires two official languages, and an official document of approval from the relevant Head of Education confirming that a learner who has received home education prior to Grade 10 has reached the required level in Grade 9. Additionally, for Entrance into Grades 11 and 12, an appropriate statement of achievement at the appropriate levels is issued by an approved or recognised assessment body. . Part-time and full-time learning opportunities are offered within the NSC, with a recommended 4.5 guided learning hours per week. NSC Mathematics aims to provide students with access to higher education, facilitate the transition of learners from education institutions to the workplace and to provide employers with a sufficient profile of a learner's competences.

The majority of programmes include assumed prior learning. Some are more specific at the subject level. For example, the IB Diploma Programme assumes that students will be familiar in core mathematics topics prior to SL and HL, including the following: Number, Sets and Numbers, Algebra, Trigonometry, Geometry, Coordinate Geometry and Statistics and Probability. NSW HSC Mathematics curricula assume that students have studied the content and achieved the outcomes of the Mathematics Years 7–10 syllabus. All learners are taught Mathematics in the lower grades (Grade R – 9). A minimum mark of 30% is required for a learner to offer Mathematics in Grade 10.

The number of recommended study hours per week and hour per year show many similarities across these Mathematics curricula.

Similar to the NSC, all programmes aim to prepare students for further studies or higher education. Facilitation of the transition of learners from education to the workplace is also highlighted by many curricula analysed here.

Subject Aims

The following table lists the stated aims of each subject according to each programme's documentation. Where curriculum documentation does not explicitly articulate aims with, for example, a subheading titled "Aims", Ecctis have selected passages or extracts which most closely resemble a brief overview of the subject's purpose. This is intended to enable comparison between the different curricula as effectively as possible. Where something not labelled "aims" has been used to stand-in for curriculum aims, this is explained in the descriptive analysis underneath the table.

Table 2: Comparison of subject aims

	Subject Aims
NSC Mathematics[12]	• To develop fluency in computation skills without relying on the usage of calculators. • Mathematical modelling is an important focal point of the curriculum. Real life problems should be incorporated into all sections whenever appropriate. Examples used should be realistic and not contrived. Contextual problems should include issues relating to health, social, economic, cultural, scientific, political and environmental issues whenever possible. • To provide the opportunity to develop in learners the ability to be methodical, to generalize, make conjectures and try to justify or prove them. • To be able to understand and work with number system. • To show Mathematics as a human creation by including the history of Mathematics. • To promote accessibility of Mathematical content to all learners. It could be achieved by catering for learners with different needs. • To develop problem-solving and cognitive skills. Teaching should not be limited to "how" but should rather feature the "when" and "why" of problem types. Learning procedures and proofs without a good understanding of why they are important will leave learners ill-equipped to use their knowledge in later life. • To prepare the learners for further education and training as well as the world of work.
IB DP Mathematics (SL)[13]	The aims of Mathematics SL are to enable students to: • enjoy mathematics, and develop an appreciation of the elegance and power of mathematics • develop an understanding of the principles and nature of mathematics • communicate clearly and confidently in a variety of contexts • develop logical, critical and creative thinking, and patience and persistence in problem-solving • employ and refine their powers of abstraction and generalization • apply and transfer skills to alternative situations, to other areas of knowledge and to future developments • appreciate how developments in technology and mathematics have influenced each other • appreciate the moral, social and ethical implications arising from the work of mathematicians and the applications of mathematics • appreciate the international dimension in mathematics through an awareness of the universality of mathematics and its multicultural and historical perspectives • appreciate the contribution of mathematics to other disciplines, and as a particular "area of knowledge" in the Theory of Knowledge (TOK) course.
IB DP Mathematics (HL)[14]	The aims of Mathematics HL are to enable students to: • enjoy mathematics, and develop an appreciation of the elegance and power of mathematics • develop an understanding of the principles and nature of mathematics • communicate clearly and confidently in a variety of contexts • develop logical, critical and creative thinking, and patience and persistence in problem-solving • employ and refine their powers of abstraction and generalization

[12] National Curriculum Statement (NCS) (2011), *Curriculum and Assessment Policy Statement Grades 10-12 Mathematics.*

[13] International Baccalaureate (2012), *Diploma Programme: Mathematics Standard Level (SL) Guide*.

[14] International Baccalaureate (2012), *Diploma Programme: Mathematics Higher Level (HL) Guide.*

	Subject Aims
	• apply and transfer skills to alternative situations, to other areas of knowledge and to future developments • appreciate how developments in technology and mathematics have influenced each other • appreciate the moral, social and ethical implications arising from the work of mathematicians and the applications of mathematics • appreciate the international dimension in mathematics through an awareness of the universality of mathematics and its multicultural and historical perspectives • appreciate the contribution of mathematics to other disciplines, and as a particular "area of knowledge" in the TOK course.
Cambridge International AS/A Level Mathematics[15]	The aims are to enable students to: • develop their mathematical knowledge and skills in a way which encourages confidence and provides satisfaction and enjoyment • develop an understanding of mathematical principles and an appreciation of mathematics as a logical and coherent subject • acquire a range of mathematical skills, particularly those which will enable them to use applications of mathematics in the context of everyday situations and of other subjects they may be studying • develop the ability to analyse problems logically • recognise when and how a situation may be represented mathematically, identify and interpret relevant factors and select an appropriate mathematical method to solve the problem • use mathematics as a means of communication with emphasis on the use of clear expression • acquire the mathematical background necessary for further study in mathematics or related subjects.
KCSE Mathematics[16]	• develop a positive attitude towards learning Mathematics; • perform mathematical operations and manipulations with confidence, speed and accuracy; • think and reason precisely, logically and critically in any given situation; • develop investigative skills in Mathematics; • identify, concretise, symbolise and use Mathematical relationships in everyday life; • comprehend, analyse, synthesise, evaluate and make generalizations so as to solve Mathematical problems; • collect, organise, represent, analyse, interpret data and make conclusions and predictions from its results; • apply mathematical knowledge and skills to familiar and unfamiliar situations; • appreciate the role, value and use of Mathematics in society; • develop a willingness to work collaboratively; • acquire knowledge and skills for further education and training; • communicate mathematical ideas.

[15] Cambridge International Examinations (2016), *AS and A Level 2016: Syllabus: Cambridge International AS and A Level Mathematics 9709.*

[16] The Kenya National Examinations Council (2014), *Kenya Certificate of Secondary Education (KCSE): Examinations Regulations and Syllabuses.*

	Subject Aims
ZIMSEC Forms 5-6 Pure Mathematics[17]	This syllabus is intended to provide a guideline for Forms 5 - 6 learners which will enable them to: • acquire enterprising skills through modelling, research and project-based learning • develop the abilities to reason logically, to communicate mathematically, and to learn co-operatively and independently • develop an appreciation of the applicability, creativity and power of pure mathematics in solving a broad range of problems • understand the nature of Pure Mathematics and its relationship to other branches of mathematics and STEM in general. • appreciate the use of ICT tools in solving pure mathematical problems • engage, persevere, collaborate and show intellectual honesty in performing tasks in Pure Mathematics, in the spirit of Unhu/ Ubuntu/Vumunhu
NSW HSC Advanced Mathematics[18]	The study of Mathematics Advanced enables students to enhance their knowledge and understanding of what it means to work mathematically, develop their understanding of the relationship between 'real-world' problems and mathematical models and extend their skills of concise and systematic communication. The Mathematics Advanced course forms a continuum to provide opportunities at progressively higher levels for students to acquire knowledge, skills and understanding in relation to concepts within the area of mathematics that have applications in an increasing number of contexts. These concepts and applications are appropriate to the students' continued experience of mathematics as a coherent, interrelated, interesting and intrinsically valuable study that forms the basis for future learning. The concepts and techniques of differential and integral calculus form a strong basis of the courses, and are developed and used across the courses, through a range of applications and in increasing complexity. The Mathematics Advanced course is focused on enabling students to appreciate that mathematics is a unique and powerful way of viewing the world to investigate order, relation, pattern, uncertainty and generality. The course provides students with the opportunity to develop ways of thinking in which problems are explored through observation, reflection and reasoning. The Mathematics Advanced course provides a basis for further studies in disciplines in which mathematics and the skills that constitute thinking mathematically have an important role. It is designed for those students whose future pathways may involve mathematics and its applications in a range of disciplines at the tertiary level.
NSW HSC Standard 1 Mathematics[19]	The study of Mathematics Standard enables students to develop their knowledge and understanding of what it means to work mathematically, improve their skills to solve problems relating to their present and future needs and aspirations, and improve their understanding of how to communicate in a concise and systematic manner. The Mathematics Standard courses are focused on enabling students to use mathematics effectively, efficiently and critically to make informed decisions in their daily lives. They provide students with the opportunities to develop an understanding of, and competence in, further aspects of mathematics through a large variety of real-world applications for a range of concurrent HSC subject.

[17] Zimbabwe Ministry of Primary and Secondary Education (2015), *Pure Mathematics Syllabus Forms 5-6*.

[18] New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Advanced Stage 6 Syllabus.*

[19] New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Standard Stage 6 Syllabus.*

	Subject Aims
	Mathematics Standard 1 is designed to help students improve their numeracy by building their confidence and success in making mathematics meaningful. Numeracy is more than being able to operate with numbers. It requires mathematical knowledge and understanding, mathematical problem-solving skills and literacy skills, as well as positive attitudes. When students become numerate they are able to manage a situation or solve a problem in real contexts, such as everyday life, work or further learning. This course offers students the opportunity to prepare for post-school options of employment or further training.
NSW HSC Standard 2 Mathematics[20]	The study of Mathematics Standard enables students to develop their knowledge and understanding of what it means to work mathematically, improve their skills to solve problems relating to their present and future needs and aspirations, and improve their understanding of how to communicate in a concise and systematic manner. The Mathematics Standard courses are focused on enabling students to use mathematics effectively, efficiently and critically to make informed decisions in their daily lives. They provide students with the opportunities to develop an understanding of, and competence in, further aspects of mathematics through a large variety of real-world applications for a range of concurrent HSC subjects. Mathematics Standard 2 is designed for those students who want to extend their mathematical skills beyond Stage 5 but are not seeking the in-depth knowledge of higher mathematics that the study of calculus would provide. This course offers students the opportunity to prepare for a wide range of educational and employment aspirations, including continuing their studies at a tertiary level.

The content of this table was drawn from:

- NSC curriculum aims were drawn from the "specific aims" subsection of the subject curriculum guide.
- IB DP curriculum aims were drawn from the "aims" subsection of the subject curriculum guide.
- Cambridge International AS/A Level curriculum aims were drawn from the "aims" subsection of the subject curriculum guide.
- KCSE aims were drawn from the "General Objectives" bullet point list in the curriculum guide, as there is no specific "aims" or "purpose" subsections.
- Zimbabwe Forms 5-6 aims were drawn from the "aims" subsection of the subject curriculum guide.
- NSW curriculum aims were drawn from the "Rationale" and "Aim" subsections of the subject curriculum guide.

NSC Mathematics aims include progression routes, for example, the aim to prepare the learners for further education and training as well as the world of work. Similar to the NSC, KSCE Mathematics, Cambridge International AS/A Level and NSW HSC Mathematics curricula include a focus on the progression of students for further study post qualification.

NSC Mathematics aims to develop skills such as problem solving and cognitive skills. This is echoed by all programmes, for example, from the IB Diploma SL and HL aims:

- Develop logical, critical and creative thinking, and patience and persistence in problem-solving

And from the NSC:

- To develop problem-solving and cognitive skills. Teaching should not be limited to

[20] Ibid.

"how" but should rather feature the "when" and "why" of problem types. Learning procedures and proofs without a good understanding of why they are important will leave learners ill-equipped to use their knowledge in later life.

NSC Mathematics aims promote the use of real-life problems that can be incorporated into all topics whenever appropriate, as well as contextual problems that include realistic issues (health, social, economic, cultural, scientific, political and environmental issues). This is also covered across the majority of Mathematics curricula analysed here (Cambridge International AS/A Level, KCSE Mathematics, NSW HSC Mathematics Advanced and Standard 1 and 2).

There are also some notable points of differences when looking across the range of subject aims. Some programmes (ZIMSEC and IB DP) include the aim to improve the use of technology to aid solving problems and applying mathematics. NSC Mathematics encourages the development of fluency in computation skills without relying on the usage of calculators. The IB DP and the NSC Mathematics include a subject aim related to the history of mathematics. More specifically, in the IB DP Mathematics HL this is evident as the subject aims seek to enable students to "appreciate the international dimension in mathematics through an awareness of the universality of mathematics and its multicultural and historical perspectives".[21] Additionally, this is also evident in one of the subject aims of the NSC Mathematics which focuses on supporting students to "show Mathematics as a human creation by including the history of Mathematics".[22]

Learning Outcomes

The following table lists the learning outcomes named in each programme's subject documentation. Where curriculum documentation does not explicitly articulate learning outcomes with, for example, a subheading titled "Learning Outcomes", Ecctis have selected lists or extracts which most closely resemble the expected knowledge, skills and competencies that students should have on completion of a programme of study. This is intended to enable comparison between the different curricula as effectively as possible. Where something not labelled "Learning Outcomes" has been used to stand-in for learning outcomes, this is explained in the descriptive analysis underneath the table.

Table 3: Comparison of learning outcomes

	Learning Outcomes
NSC Mathematics[23]	To develop essential mathematical skills the learner should: • develop the correct use of the language of Mathematics; • collect, analyse and organise quantitative data to evaluate and critique conclusions; mathematics grades 10-12 caps 9 • use mathematical process skills to identify, investigate and solve problems creatively and critically; • use spatial skills and properties of shapes and objects to identify, pose and solve problems creatively and critically; • participate as responsible citizens in the life of local, national and global communities; • communicate appropriately by using descriptions in words, graphs, symbols, tables and diagrams

21 International Baccalaureate (2012), *Diploma Programme: Mathematics Higher Level (HL) Guide*, p. 8.

22 National Curriculum Statement (NCS) (2011), *Curriculum and Assessment Policy Statement Grades 10-12 Mathematics*, p. 8.

23 Ibid.

	Learning Outcomes
IB DP Mathematics (SL)[24]	Having followed a DP Mathematics SL curriculum, students will be expected to demonstrate the following. • Knowledge and understanding: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts. • Problem-solving: recall, select and use their knowledge of mathematical skills, results and models in both real and abstract contexts to solve problems. • Communication and interpretation: transform common realistic contexts into mathematics; comment on the context; sketch or draw mathematical diagrams, graphs or constructions both on paper and using technology; record methods, solutions and conclusions using standardized notation. • Technology: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems. • Reasoning: construct mathematical arguments through use of precise statements, logical deduction and inference, and by the manipulation of mathematical expressions. • Inquiry approaches: investigate unfamiliar situations, both abstract and real-world, involving organizing and analysing information, making conjectures, drawing conclusions and testing their validity.
IB DP Mathematics (HL)[25]	Having followed a DP Mathematics HL curriculum, students will be expected to demonstrate the following. • Knowledge and understanding: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts. • Problem-solving: recall, select and use their knowledge of mathematical skills, results and models in both real and abstract contexts to solve problems. • Communication and interpretation: transform common realistic contexts into mathematics; comment on the context; sketch or draw mathematical diagrams, graphs or constructions both on paper and using technology; record methods, solutions and conclusions using standardized notation. • Technology: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems. • Reasoning: construct mathematical arguments through use of precise statements, logical deduction and inference, and by the manipulation of mathematical expressions. • Inquiry approaches: investigate unfamiliar situations, both abstract and real-world, involving organizing and analysing information, making conjectures, drawing conclusions and testing their validity.
Cambridge International AS/A Level Mathematics[26]	The assessment objectives (AOs) are: AO1 Knowledge and understanding • Show understanding of relevant mathematical concepts, terminology and notation • Recall accurately and use appropriate mathematical manipulative techniques AO2 Application and communication • Recognise the appropriate mathematical procedure for a given situation

[24] International Baccalaureate (2012), *Diploma Programme: Mathematics Standard Level (SL) Guide*.

[25] International Baccalaureate (2012), *Diploma Programme: Mathematics Higher Level (HL) Guide*.

[26] Cambridge International Examinations (2016), *AS and A Level 2016: Syllabus: Cambridge International AS and A Level Mathematics 9709*.

	Learning Outcomes
	• Apply appropriate combinations of mathematical skills and techniques in solving problems • Present relevant mathematical work, and communicate corresponding conclusions, in a clear and logical way
KCSE Mathematics[27]	• develop a positive attitude towards learning Mathematics; • perform mathematical operations and manipulations with confidence, speed and accuracy; • think and reason precisely, logically and critically in any given situation; • develop investigative skills in Mathematics; • identify, concretise, symbolise and use Mathematical relationships in everyday life; • comprehend, analyse, synthesise, evaluate and make generalizations so as to solve Mathematical problems; • collect, organise, represent, analyse, interpret data and make conclusions and predictions from its results; • apply mathematical knowledge and skills to familiar and unfamiliar situations; • appreciate the role, value and use of Mathematics in society; • develop a willingness to work collaboratively; • acquire knowledge and skills for further education and training; • communicate mathematical ideas
ZIMSEC Forms 5-6 Pure Mathematics[28]	By the end of the two-year learning period, the learners should be able to: • make use of a variety of mathematical skills (including graphing, proving, modelling, finding pattern and problem solving) in the learning and application of Pure Mathematics. • communicate pure mathematical ideas and information • produce imaginative and creative work arising from pure mathematical ideas • choose strategies to construct arguments and proofs in both concrete and abstract settings • construct and use mathematical models in solving problems in life • apply pure mathematical ideas in other branches of mathematics and STEM in general. • demonstrate perseverance, diligence, cooperation and intellectual honesty. • use ICT tools to solve pure mathematical problems. • conduct research projects including those related to enterprise
NSW HSC Advanced Mathematics[29]	Students: • develop knowledge, skills and understanding about efficient strategies for pattern recognition, generalisation and modelling techniques • develop the ability to use mathematical concepts and skills and apply complex techniques to the modelling and solution of problems in algebra and functions, measurement, financial mathematics, calculus, data, statistics and probability • develop the ability to use advanced mathematical models and techniques, aided by appropriate technology, to organise information, investigate, model and solve problems and interpret a variety of practical situations • develop the ability to interpret and communicate mathematics logically and concisely in a variety of forms.

[29] New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Advanced Stage 6 Syllabus.*

[27] The Kenya National Examinations Council (2014), *Kenya Certificate of Secondary Education (KCSE): Examinations Regulations and Syllabuses.*

[28] Zimbabwe Ministry of Primary and Secondary Education (2015), *Pure Mathematics Syllabus Forms 5-6*.

	Learning Outcomes
	Students value and appreciate: • mathematics as an essential and relevant part of life, recognising that its development and use have been largely in response to human needs by societies all around the globe • the importance of resilience and self-motivation in undertaking mathematical challenges and the importance of taking responsibility for their own learning and evaluation of their mathematical development
NSW HSC Standard 1 Mathematics[30]	Students: • develop the ability to apply reasoning, and the use of appropriate language, in the evaluation and construction of arguments and the interpretation and use of models based on mathematical concepts • develop the ability to use concepts and apply techniques to the solution of problems in algebra and modelling, measurement, financial mathematics, data and statistics, probability and networks • develop the ability to use mathematical skills and techniques, aided by appropriate technology, to organise information and interpret practical situations • develop the ability to interpret and communicate mathematics in a variety of written and verbal forms, including diagrams and graphs. Students value and appreciate: • mathematics as an essential and relevant part of life, recognising that its development and use have been largely in response to human needs by societies all around the globe • the importance of resilience in undertaking mathematical challenges, taking responsibility for their own learning and evaluating their mathematical development.
NSW HSC Standard 2 Mathematics[31]	See Mathematics Standard 1, above.

Where learning outcomes were drawn from:

- NSC curriculum learning outcomes were drawn from the "specific skills" subsection of the subject curriculum guide.
- IB DP curriculum learning outcomes were drawn from the "assessment objectives" subsection of the subject curriculum guide.
- Cambridge International AS/A Level curriculum learning outcomes were drawn from the "assessment objectives" subsection of the subject curriculum guide.
- KCSE learning outcomes were drawn from the "General Objectives" bullet point list in the curriculum guide, as there is no specific "learning outcomes" subsections.
- Zimbabwe Forms 5-6 learning outcomes were drawn from the "syllabus objectives" subsections of the subject curriculum guide.
- NSW HSC curriculum learning outcomes were drawn from "Objectives" subsections of the subject curriculum guide.

NSC Mathematics covers a variety of different skills that are presented as learning outcomes, such as: spatial skills, problem-solving, critical analysis, and mathematical process skills. The spatial skills element of the NSC learning outcomes is not mentioned in the other programmes' learning outcomes.

Problem-solving is mentioned as an essential

30 New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Standard Stage 6 Syllabus.*

31 Ibid.

mathematics skill that the learner should develop in NSC Mathematics. Development of problem-solving skills as a learning outcome is also key for the majority of the other programmes (IB DP SL and HL, Cambridge International AS/A Level, KCSE Mathematics, and ZIMSEC).

The development of mathematical process skills (included in the NSC specifications) is not widely used across other Mathematics programmes; however, a similar outcome is included in ZIMSEC's learning outcomes as the following:

- make use of a variety of mathematical skills (including graphing, proving, modelling, finding pattern and problem solving) in the learning and application of Pure Mathematics.

Communication has also been labelled as a key learning outcome in NSC Mathematics through the use of descriptions in words, graphs, symbols, tables and diagrams. Again, communication is an important skill that has been recognised as a learning outcome across all of the other programmes. For example, from NSW HSC Standard 1 and 2:

- develop the ability to interpret and communicate mathematics in a variety of written and verbal forms, including diagrams and graphs.

A skill that is not explicitly touched upon by the NSC learning outcomes is the development of reasoning skills, which is commonly mentioned across other programmes (KSCE Mathematics, NSW HSC Standard 1 and 2 and IB Diploma SL and HL). For example, from NSW HSC Standard 1 and 2:

- develop the ability to apply reasoning, and the use of appropriate language, in the evaluation and construction of arguments and the interpretation and use of models based on mathematical concepts.

However, reasoning is included in the NSC's description of skills to be developed within the cognitive level of "Complex Procedures". Specifically, the specification makes reference to "problems involve complex calculations and/or higher order reasoning". Moreover, within the cognitive level of "Problem Solving" it is suggested that higher order reasoning and processes are involved.

Content Areas

The following table summarises the different content areas included within each of the comparison subjects. For ease of comparison, content areas have been grouped by Ecctis. The groups in the table below are labels assigned by Ecctis according to analysis of subject documentation and they do not necessarily reflect the groupings or labels used in the subject documentation for each programme. For the full details of subject content in each programme – listed in the order provided by each programme's documentation.

Table 4: Comparison of content areas

	Core Mathematics	Statistics	Mechanics	Other
NSC Mathematics[32]	Algebra and Equations (and inequalities) Patterns and Sequences Functions and graphs Differential Calculus (grade 12 only) Analytical geometry Trigonometry Euclidean Geometry and Measurement	Probability Statistics		Finance and Growth (grade 10 only) Finance, growth and decay (grade 11 and 12 only)
IB DP Mathematics (SL)[33]	Algebra Functions and equations Circular functions and trigonometry Vectors Calculus	Statistics and probability		Mathematical exploration
IB DP Mathematics (HL)[34]	Algebra Functions and Equations Circular Functions and Trigonometry Vectors Calculus (further option available) Sets, relations, and groups (optional)	Statistics and Probability (further option available)		Discrete mathematics (optional) Mathematical exploration
Cambridge International AS/A Level Mathematics[35]	Quadratics Functions Coordinate Geometry Circular Measure Trigonometry Series Differentiation Integration Vectors Logarithmic and exponential functions Numerical solution of equations Differential equations Complex Numbers	Representation of data Permutations and combinations Probability Discrete random variables The Normal Distribution The Poisson Distribution Linear combinations of random variables Continuous random variables Sampling and estimation Hypothesis tests	Forces and Equilibrium Kinematics of motion in a straight line Newton's laws of motion Energy, work and power Motion of a projectile Equilibrium of a rigid body Uniform motion in a circle Hooke's Law Linear Motion under a variable force	

32 National Curriculum Statement (NCS) (2011), *Curriculum and Assessment Policy Statement Grades 10-12 Mathematics*.

33 International Baccalaureate (2012), *Diploma Programme: Mathematics Standard Level (SL) Guide*.

34 International Baccalaureate (2012), *Diploma Programme: Mathematics Higher Level (HL) Guide*.

35 Cambridge International Examinations (2016), *AS and A Level 2016: Syllabus: Cambridge International AS and A Level Mathematics 9709*.

	Core Mathematics	Statistics	Mechanics	Other
KCSE Mathematics[36]	**Numbers** **Measurement (1)** **Measurement (2)** **Algebra** **Linear Programming** **Surds** **Sequences and Series** **Binomial Expansions** **Formulae and Variation** **Geometry** **Graphs** **Trigonometry (1)** **Trigonometry (2)** **Trigonometry (3)** **Transformation** **Vectors** **Area approximation** **Elementary Calculus** **Navigation**	**Statistics and Probability**		**Commercial Arithmetic**
ZIMSEC Forms 5-6 Pure Mathematics[37]	**Algebra** • Indices and Probability • Polynomials • Identities, equations and inequalities • Functions • Relations • Matrices • Mathematical induction • Groups **Geometry and vectors** • Graphs and coordinate geometry • Vectors (up to three dimensions) **Series and Sequences** • Sequences • Series **Trigonometry** • Plane Trigonometry • Trigonometrical Functions			

[36] The Kenya National Examinations Council (2014), *Kenya Certificate of Secondary Education (KCSE): Examinations Regulations and Syllabuses.*

[37] Zimbabwe Ministry of Primary and Secondary Education (2015), *Pure Mathematics Syllabus Forms 5-6.*

	Core Mathematics	Statistics	Mechanics	Other
	Calculus • Differentiation • Integration • 1st Order differential equations **Numerical methods** • Numerical Methods **Complex numbers** • Complex Numbers			
NSW HSC Advanced Level[38]	**Functions** • Working with functions • Graphing techniques **Trigonometric Functions** • Trigonometry and measure of angles • Trigonometric functions and identities • Trigonometric functions and graphs **Calculus** • Introduction to differentiation • Differential calculus • Applications of differentiation • Integral Calculus **Exponential and Logarithmic Functions** • Logarithms and Exponentials	**Statistical Analysis** • Probability and discrete probability distributions • Descriptive Statistics and Bivariate Data Analysis • Random Variables		**Financial Mathematics** • Modelling financial situations
NSW HSC Standard 1 Mathematics[39]	Algebra • Formulae and Equations • Linear Relationships • Types of Relationships **Measurement** • Applications of Measurement • Working with Time • Right-angled Triangles • Rates • Scale Drawings	**Statistical Analysis** • Data Analysis • Relative Frequency and Probability • Further Statistical Analysis		**Financial Mathematics** • Money Matters • Investment • Depreci-ation and **Loans** **Networks** • Networks and Paths

[38] New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Advanced Stage 6 Syllabus.*

[9] New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Standard Stage 6 Syllabus.*

	Core Mathematics	Statistics	Mechanics	Other
NSW HSC Standard 2 Mathematics[40]	**Algebra** • Formulae and Equations • Linear Relationships • types of relationships • Measurement • Applications of Measurement • Working with Time • Non-right-angled Trigonometry • Rates and ratios	**Statistical Analysis** • Bivariate data Analysis • The Normal Distribution • Data Analysis • Relative Frequency and Probability	-	**Financial Mathematics** • Investments and Loans • Annuities • Money Matters **Networks** • Network Concepts • Critical Path Analysis

The NSC content syllabus contained mostly pure mathematics, with some applied mathematics in the areas of statistics and finance. Pure mathematic topics in the NSC which were commonly identified in other countries' curricula were those involving algebra, sequences, functions, trigonometry, and calculus. However, it can be noted that functions and trigonometry were covered in less detail in KCSE Mathematics and these along with calculus were studied in less or no detail in NSW Standard 1 and 2. Analytical Geometry content was identified in ZIMSEC, Cambridge International, KCSE, and NSW. In contrast, the topic of Euclidean Geometry and the content within it was significantly less common to other programmes. With regards to applied topics, all programmes except ZIMSEC offered statistics content as part of their programme. ZIMSEC Pure Mathematics, as the name implies, is the only programme not to offer any applied topics such as statistics, finance, mechanics, or decision mathematics. Moreover, though KCSE offered statistics, it was not covered in as much as the same detail as NSC. Furthermore, similar to the NSC, financed-based topics were included in KCSE Mathematics, NSW HSC Advanced level, and Standard 1 and 2, though not in Cambridge International, IB DP or ZIMSEC.

When looking across the comparison programmes' content, there were some common topics identified that were not present in the NSC. Firstly, the topic of Integration was present in all comparison programmes (except NSW Standard Level), which contrasts with the NSC focus on differential calculus only. Another topic common to other programmes was that of Vectors, which was identified in IB DP SL/HL, Cambridge International AS/A Level, ZIMSEC, and KCSE (for NSW, vectors are covered in Mathematics Extension 1 and 2, but not in Advanced or Standard). Also worthy of note were differences in the topic of Statistics. Though much of the content in NSC was similar to other programmes, the sub-topic of linear regression was only found in NSW content. Instead, programmes tended to focus on random variables and the binomial and normal probability distributions.

Additionally, there are a few other notable topics present in other comparison curricula content, though, unlike the topics mentioned above, these tended to be unique to specific programmes rather than common. Firstly, Cambridge International AS/A Level is unique in offering a main topic area of 'Mechanics', indeed no other programme (including NSC) offers anything similar. Furthermore, at A-level,

[40] Ibid.

there is a wider range of statistical topics offered, including Continuous Random Variables, Sampling and Estimation, Hypothesis Testing, and Linear Combinations. It is important to note that, unlike NSC, International AS level students can choose to take more pure mathematics instead of any applied. However, International A level students must take applied mathematics, and can study either mechanics or statistics in depth (where the topics listed above would be covered), or they can study a combination of both (in less depth). Turning to IB DP curricula, the IB DP HL requires students to study an "additional higher level" topic, with the options being either extensions of content in Calculus and Statistics and Probability, or a new topic – either Discrete Mathematics or Sets, relations, and groups. The content in each of these topics is not present in the NSC. Finally, NSW Standard Level covers topics in decision mathematics (Networks and Critical Path Analysis) which are not present in the NSC content.

Though NSC generally covers topics in similar depth and detail to most other programmes and has complexity in certain topics such as Euclidean Geometry, it can be noted that more areas of complexity can be identified in the content of some other programmes, namely Cambridge International A Level, IB DP HL, and ZIMSEC Forms 5 and 6. However, it must be emphasised that these are the more advanced options of study within each programme and likely to be taken only by those with a strong mathematical ability. For Cambridge International A Level, there are high levels of complexity in the topics of integration, vectors, complex numbers, differential equations, and the applied mathematics options (statistics/ mechanics). For IB DP HL there are high levels of complexity in the topics of complex numbers, proof by induction, vectors, integration, and the additional higher-level topics. For ZIMSEC Forms 5 and 6, areas demonstrating complexity are complex numbers, Maclaurin and Taylor Series, proof by induction, integration, differential equations, matrices, vectors, and numerical methods.[41]

As part of internal assessment, the NSC includes investigations with an aim to develop students' "skills of systematic investigation into special cases with a view to observing general trends, making conjectures and proving them". It is suggested that NSC Mathematics investigations are marked using rubrics which can be specific to the task, or generic, listing the number of marks awarded for each skill (40% for communicating individual ideas and discoveries; 35% for the effective consideration of special cases; 20% for generalising, making conjectures and proving or disproving these conjectures; and 5% for presentation).[42] Similarly, IB DP Mathematics includes the "Mathematical exploration", which requires students to choose an area of mathematics to investigate and produce a report of length 6 – 12 pages. Students are marked on Communication, Mathematical Presentation, Personal Engagement, Reflection, and Use of Mathematics.[43] As can be seen, there are both similar and different criteria here to the NSC. Overall, both programmes offer investigative tasks which allow for mathematical exploration and can be accessed by all students - whilst having scope for higher-attaining students to produce work showing deeper complexity and understanding. Though, it can be noted that where IB has one, extensive project, the NSC have more frequent internal assessments, for which investigations make up a part of. Other programmes offering investigative tasks as part of internal assessment are ZIMSEC and NSW

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41 Some of these topics (integration, vectors, complex numbers) do not automatically imply complexity, rather they are listed on the basis that the programme includes sub-topics within them that demonstrate this.

41 National Curriculum Statement (NCS) (2011), *Curriculum and Assessment Policy Statement Grades 10-12 Mathematics*, p. 51.

43 International Baccalaureate (2012), *Diploma Programme: Mathematics Standard Level (SL) Guide*, p. 47.

Standard/Advanced. For NSW, there are several ways that these can be carried out, including an investigation of independent choice, a set investigation/project, a guided investigation, or scaffolded learning tasks culminating in an open-ended or modelling style problem. The criteria and weighting on which these are assessed is unclear in documentation, however it is stated that the assessments should allow for "Working Mathematically" which includes "Reasoning, Justifying, Communicating, Problem-Solving and Understanding"[44] – reflecting some of the criteria in the NSC. There is limited information on ZIMSEC projects, though it is expected that one is to be undertaken as part of "Continuous Assessment". The weighting of assessments should be 20% Knowledge and Comprehension, 40% Application and 40% Evaluation and Synthesis[45], and should also be in line with the assessment objectives. Finally, other programmes, Cambridge International AS/A Level and KCSE Mathematics do not include an investigation-style task as part of internal assessment.

Assessment Objectives

The table below provides a list of the subject-specific assessment objectives for each subject. Where curriculum documentation does not explicitly articulate assessment objectives with, for example, a subheading titled "Assessment Objectives", Ecctis have selected lists or extracts which most closely resemble the knowledge, skills and competencies that students are assessed on. This is intended to enable comparison between the different curricula as effectively as possible. Where something not labelled "Assessment Objectives" has been used to stand-in for assessment objectives, this is explained in the descriptive analysis underneath the table.

Table 5: Comparison of assessment objectives

	Assessment Objectives
NSC Mathematics[46]	Documentation indicates cognitive levels (including weighting percentage) along with corresponding skills to be demonstrated: **Knowledge (20%)** • Straight recall • Identification of correct formula on the information sheet (no changing of the subject) • Use of mathematical facts • Appropriate use of mathematical vocabulary **Routine Procedures (35%)** • Estimation and appropriate rounding of numbers • Proofs of prescribed theorems and derivation of formulae • Identification and direct use of correct formula on the information sheet (no changing of the subject) • Perform well known procedures • Simple applications and calculations which might involve few steps • Derivation from given information may be involved • Identification and use (after changing the subject) of correct formulae • Generally similar to those encountered in class

[46] National Curriculum Statement (NCS) (2011), *Curriculum and Assessment Policy Statement Grades 10-12 Mathematics.*

[44] NSW Education Standards Authority, available at Working Mathematically | NSW Education Standards

[45] Zimbabwe Ministry of Primary and Secondary Education (2015), *Pure Mathematics Syllabus Forms 5-6*, p. 30.

	Assessment Objectives
	Complex Procedures (30%) • Problems involve complex calculations and/or higher order reasoning • There is often not an obvious route to the solution • Problems need not be based on a real-world context • Could involve making significant connections between different representations • Require conceptual understanding **Problem Solving (15%)** • Non-routine problems (which are not necessarily difficult) • Higher order reasoning and processes are involved • Might require the ability to break the problem down into its constituent parts
IB DP Mathematics (SL)[47]	Having followed a DP Mathematics SL curriculum, students will be expected to demonstrate the following. • **Knowledge and understanding**: recall, select and use their knowledge of mathematical facts, concepts and techniques in a variety of familiar and unfamiliar contexts. • **Problem-solving**: recall, select and use their knowledge of mathematical skills, results and models in both real and abstract contexts to solve problems. • **Communication and interpretation**: transform common realistic contexts into mathematics; comment on the context; sketch or draw mathematical diagrams, graphs or constructions both on paper and using technology; record methods, solutions and conclusions using standardized notation. • **Technology**: use technology, accurately, appropriately and efficiently both to explore new ideas and to solve problems. • **Reasoning**: construct mathematical arguments through use of precise statements, logical deduction and inference, and by the manipulation of mathematical expressions. • **Inquiry approaches**: investigate unfamiliar situations, both abstract and real-world, involving organizing and analysing information, making conjectures, drawing conclusions and testing their validity.
IB DP Mathematics (HL)[48]	Having followed a DP Mathematics HL curriculum, students will be expected to demonstrate the following. • *See SL above*
Cambridge International AS/A Level Mathematics[49]	The assessment objectives (AOs) are: **AO1 Knowledge and understanding** • Show understanding of relevant mathematical concepts, terminology and notation • Recall accurately and use appropriate mathematical manipulative techniques **AO2 Application and communication** • Recognise the appropriate mathematical procedure for a given situation • Apply appropriate combinations of mathematical skills and techniques in solving problems • Present relevant mathematical work, and communicate corresponding conclusions, in a clear and logical way

47 International Baccalaureate (2012), *Diploma Programme: Mathematics Standard Level (SL) Guide*.

48 International Baccalaureate (2012), *Diploma Programme: Mathematics Higher Level (HL) Guide*.

49 Cambridge International Examinations (2016), *AS and A Level 2016: Syllabus: Cambridge International AS and A Level Mathematics 9709*.

	Assessment Objectives
KCSE Mathematics[50]	No assessment objectives are identified in subject documentations, but general objectives are listed as: • develop a positive attitude towards learning Mathematics; • perform mathematical operations and manipulations with confidence, speed and accuracy; • think and reason precisely, logically and critically in any given situation; • develop investigative skills in Mathematics; • identify, concretise, symbolise and use Mathematical relationships in everyday life; • comprehend, analyse, synthesise, evaluate and make generalizations so as to solve Mathematical problems; • collect, organise, represent, analyse, interpret data and make conclusions and predictions from its results; • apply mathematical knowledge and skills to familiar and unfamiliar situations; • appreciate the role, value and use of Mathematics in society; • develop a willingness to work collaboratively; • acquire knowledge and skills for further education and training; • communicate mathematical ideas.
ZIMSEC Forms 5-6 Pure Mathematics[51]	The following skills are identified, along with task-specific weightings: • Skill 1: Knowledge; Comprehensive • Skill 2: Application; Analysis • Skill 3: Synthesis; Evaluation. The assessment will test candidate's ability to: • use mathematical symbols, terms and definitions appropriately • sketch graphs accurately • use appropriate formulae, algorithms and strategies to solve routine and non-routine problems in Pure Mathematics • solve problems in Pure Mathematics systematically • apply mathematical reasoning and communicate mathematical ideas clearly • conduct mathematical proofs in the expected manner • construct and use appropriate mathematical models for a given life situation • conduct research projects (including those related to enterprise) accurately and systematically.
NSW HSC Advanced Mathematics[52]	The two key components of assessment are identified as: • Understanding, Fluency, and Communicating (50%) • Problem Solving, Reasoning and Justification (50%). Students: • develop knowledge, skills and understanding about efficient strategies for pattern recognition, generalisation and modelling techniques • develop the ability to use mathematical concepts and skills and apply complex techniques to the modelling and solution of problems in algebra and functions, measurement, financial mathematics, calculus, data, statistics and probability

50 The Kenya National Examinations Council (2014), *Kenya Certificate of Secondary Education (KCSE): Examinations Regulations and Syllabuses.*

51 Zimbabwe Ministry of Primary and Secondary Education (2015), *Pure Mathematics Syllabus Forms 5-6.*

52 New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Advanced Stage 6 Syllabus.*

	Assessment Objectives
	• develop the ability to use advanced mathematical models and techniques, aided by appropriate technology, to organise information, investigate, model and solve problems and interpret a variety of practical situations • develop the ability to interpret and communicate mathematics logically and concisely in a variety of forms. Students value and appreciate: • mathematics as an essential and relevant part of life, recognising that its development and use have been largely in response to human needs by societies all around the globe • the importance of resilience and self-motivation in undertaking mathematical challenges and the importance of taking responsibility for their own learning and evaluation of their mathematical development
NSW HSC Standard 1 Mathematics[53]	See above.
NSW HSC Standard 2 Mathematics[54]	See above.

Some programmes do not specifically name "assessment objectives". The content of this table was drawn from:

- NSC curriculum assessment objectives were drawn from the "cognitive levels" information in the subject curriculum guide.
- IB DP curriculum assessment objectives were drawn from the assessment objectives subsections of the subject curriculum guide.
- Cambridge International AS/A Level curriculum assessment objectives were drawn from the assessment objectives subsection of the subject curriculum guide.
- KCSE assessment objectives were drawn from the "General Objectives" bullet point list in the curriculum guide, as there is no specific "assessment objectives" subsection.
- Zimbabwe Forms 5-6 assessment objectives were drawn from the assessment objectives subsections of the subject curriculum guide.
- NSW curricula assessment objectives were drawn from "Objectives" and "Outcomes" subsections of the subject curriculum guide.

NSC Mathematics describes the skills that should be demonstrated during the programme. These focus on the use and understanding of topics covered in the syllabus. The assessment objectives are mathematics-focused, which include identification and use of correct formula, making significant connections between different representations, estimation and appropriate rounding of numbers, simple applications, and calculations.

Cambridge International AS/A Level presents three general key assessment objectives, which are followed by several more specific sub-objectives. Similar to NSC Mathematics, Cambridge International AS/A Level and ZIMSEC focus on mathematics-based objectives such as the objective to show understanding of relevant mathematical concepts, terminology, and notation. Both Cambridge International AS/A Level and NSC Mathematics include the ability to recall information as an assessment objective.

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53 New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Standard Stage 6 Syllabus.*

54 Ibid.

Other programmes that list specific skills to be assessed include IB DP, KCSE Mathematics, and NSW HSC Advanced, Standard 1 and 2, which include a focus on the development of skills such as communication, collaboration, critical analysis, reasoning and problem-solving. The objectives in KCSE Mathematics are not topic-based but describe what students will obtain from the curriculum as a whole.

Assessment Methods

The table below demonstrates some key features of the methods used to assess each subject.

Table 6: Comparison of assessment methods

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
NSC Mathematics[55]	The final examination is worth a total of 75% of the final mark. Grade 12: Assessment term 4: • **Final Examination** Paper 1: 150 marks, 3 hours Paper 2: 150 marks, 3 hours An information sheet is included An approved scientific calculator is allowed in the examination	All internal assessments contribute to a final percentage of 25% of the final mark. Grade 10: Assessment term 1: • **Investigation or project** (at least 50 marks) • **Test** (at least 50 marks and 1 hour) Assessment term 2: • **Assignment/test** (at least 50 marks) • **Mid-year examination** (at least 100 marks, one paper of 2 hours (100 marks) or two papers, one, 1 hour (50 marks) and the other, 1 hour (50 marks) Assessment term 3: • **Two tests** (at least 50 marks and 1 hour) Assessment term 4: • **Test** (at least 50 marks) • **Examination Paper 1**: 2 hours, 100 marks Paper 2:, 2 hours 100 marks Grade 11: Assessment term 1: • **Investigation or project** (at least 50 marks)	Four cognitive levels are used to guide all assessment tasks as the following: Knowledge: 20% Routine Procedures: 35% Complex Procedures: 30% Problem Solving: 15% Questions in both Papers 1 and 2 will assess performance at different cognitive levels with an emphasis on process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of contexts. The examination paper consists of all short, multiple-part questions.

[55] Department of Basic Education Republic of South Africa (2017), *Mathematics: Examination Guidelines Grade 12 2017*; National Curriculum Statement (NCS) (2011), *Curriculum and Assessment Policy Statement Grades 10-12 Mathematics.*

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
NSC Mathematics[55] continued		Assessment term 2: • **Assignment** (at least 50 marks) • **Mid-year Examination Paper 1**: 2 hours, 100 marks Paper 2:, 2 hours 100 marks No assessment in term 3 Assessment term 4: • **Test** (at least 50 marks) • **Examination Paper 1**: 3 hours, 150 marks Paper 2:, 3 hours 150 marks Grade 12: Assessment term 1: • **Investigation or project** (at least 50 marks) Assessment: The focus of this task is on mathematical processes. Some of these processes are: specialising, classifying, comparing, inferring, estimating, generalising, making conjectures, validating, proving and communicating mathematical ideas • **Assignment or tes**t (at least 50 marks) • **Test** (at least 50 marks) Assessment term 2: • **Assignment** (at least 50 marks) • **Examination** (300 marks) Assessment term 3: • **Test** (at least 50 marks) • **Preliminary examinations** (300 marks)	

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
IB DP Mathematics SL[56]	External assessment (3 hours) worth a total of 80% of the final mark. Paper 1: • 1 hour 30 minutes • No calculator allowed. • 90 marks • Worth 40%. Paper 2: • 1 hour 30 minutes • Graphic display calculator required. • 90 marks Formula booklet provided	Internal assessment worth a total of 20% of the final mark. Internal assessment in mathematics SL is an individual exploration. This is a piece of written work that involves investigating an area of mathematics. (20 marks) This component is internally assessed by the teacher and externally moderated by the IB at the end of the course. Mathematics exploration is assessed against the following five criteria: • Communication • Mathematical presentation • Personal Engagement • Reflection • Use of Mathematics	External assessment: Paper 1: Section A: • Short, multiple-part questions • Section B: • Multiple-part questions Paper 2: Section A: • Short, multiple-part questions • Section B: • Multiple-part questions In paper 1 and paper 2, full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations (in the form of, for example, diagrams, graphs or calculations). Where an answer is incorrect, some marks may be given for correct method, provided this is shown by written working.
IB DP Mathematics HL[57]	External assessment (5 hours) worth a total of 80% of the final mark. Paper 1: • 2 hours • No calculator allowed. • 100 marks • Worth 30%	Internal assessment worth a total of 20% of the final mark. Internal assessment in Mathematics SL is an individual exploration. This is a piece of written work that involves investigating an area of mathematics. (20 marks)	External Assessment: Paper 1: Section A: • Short, multiple-part questions Section B: • Multiple-part questions

[56] International Baccalaureate (2012), *Diploma Programme: Mathematics Standard Level (SL) Guide*.

[57] International Baccalaureate (2012), *Diploma Programme: Mathematics Higher Level (HL) Guide*.

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
IB DP Mathematics HL[57] continued	Paper 2: • 2 hours • Graphic display calculator required. • 100 marks • Worth 30% Paper 3: • 1 hour • Graphic display calculator required. • 50 marks • Worth 20% Formula booklet provided	Mathematics exploration is assessed against the following five criteria: • Communication • Mathematical presentation • Personal Engagement • Reflection • Use of Mathematics	Paper 2: Section A: • Short, multiple-part questions Section B: • Multiple-part questions Paper 3: • Multiple-part questions In paper 1 and paper 2, full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations (in the form of, for example, diagrams, graphs or calculations). Where an answer is incorrect, some marks may be given for correct method, provided this is shown by written working.
Cambridge International AS/A Level Mathematics[58]	AS Level: Paper 1: Pure mathematics (P1) • 1 hour 45 minutes • 75 marks • Worth 60% of total marks AND Paper 2: Pure Mathematics (P2) OR Paper 4: Mechanics 1 (M1) OR Paper 6: Probability & Statistics (S1)	No internal assessments	All questions are short, multiple-part questions

[58] Cambridge International Examinations (2016), *AS and A Level 2016: Syllabus: Cambridge International AS and A Level Mathematics 9709*.

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
Cambridge International AS/A Level Mathematics[58] continued	Paper 2, 4, 6: • 1 hour 15 minutes • 50 marks • Worth 40% of total marks A Level: Paper 1: Pure mathematics (P1) AND Paper 3: Pure Mathematics (P3) Paper 1 and 3: • 1 hour 45 minutes • 75 marks • Worth 30% of total marks AND EITHER Paper 4: Mechanics 1 (M1) AND Paper 6: Probability & Statistics 1 (S1) OR Paper 4: Mechanics 1 (M1) AND Paper 5: Mechanics 2 (M2) OR OR Paper 6: Probability & Statistics (S1) AND Paper 7: Probability & Statistics 2 (S2) Paper 4, 5, 6, 7: • 1 hour 15 minutes • 50 marks • Worth 20% of total marks		

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
Cambridge International AS/A Level Mathematics[58] continued	Calculator allowed in all examinations Formula sheet provided in all examinations		
KCSE Mathematics[59]	Paper 1: 2 hours 30 minutes - 100 marks Paper 2: 2 hours 30 minutes - 100 marks	No internal assessments	Paper 1:. The paper shall consist of two sections: Section 1 and II. Section I: 50 marks. 16 compulsory short-answer questions Section II : 50 marks - A choice of 8 short, multi-part questions for candidates to answer any 5. Paper 2: The paper shall consist of two sections: Section 1 and II. Section I: 50 marks. 16 compulsory short-answer questions. Section II: 50 marks. A choice of 8 short, multi-part questions, for candidates to answer any 5.

[59] The Kenya National Examinations Council (2014), Kenya Certificate of Secondary Education (KCSE): *Examinations Regulations and Syllabuses.*

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
ZIMSEC Forms 5-6 Pure Mathematics[60]	Summative assessment worth 70% of the total mark. Consists of 2 papers worth 35% of total marks each.	Continuous assessment for Form 5 – 6 will consists of topic tasks, written tests, end of term examinations, project and profiling to measure soft skills. Worth 30% of the total mark. From term two to five, candidates are expected to have done the following continuous assessment recorded tasks: • 1 Topic task per term • 2 Written tests per term • 1 End of term test per term • 1 Project in five terms Three skills are tested throughout the continuous assessment: • Knowledge Comprehensive • Application Analysis • Synthesis Evaluation	Paper 1 and Paper 2 both consist of short and multi-part questions, occasionally featuring interpretation of graphs. All questions are compulsory.
NSW HSC Advanced Mathematics[61]	The formal written examination will consist of a formal written paper worth 100 marks. Paper (3 hours) Calculators approved by NESA may be used Reference sheet is provided	Year 11: School based assessment programme includes the following requirements: • 3 assessment tasks • The minimum weighting for an individual task is 20% • The maximum weighting for an individual task is 40% • One task must be an assignment or investigation-style task with a weighting of 20-30%	Formal written examination: Paper will consist of two sections Section 1 (10 marks)- • Objective-response questions (Multiple choice) • 10 Questions

[60] Zimbabwe Ministry of Primary and Secondary Education (2015), *Pure Mathematics Syllabus Forms 5-6.*

[61] New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Advanced Stage 6 Syllabus.*

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
NSW HSC Advanced Mathematics[61] continued		Year 12: • A maximum of 4 assessment tasks • The minimum weighting for an individual task is 10% • The maximum weighting for an individual task is 40% • One task must be an assignment or investigation-style task with a weighting of 15-30% • Only one task may be formal written examination with a maximum weighting of 15-30%	Section 2 (90 Marks)- • Short answer questions • Multiple-part questions. • 37 to 42 questions.
NSW HSC Standard 1 Mathematics[62]	The examination will consist of a formal written paper worth 80 marks. The time allowed is 2 hours plus 10 minutes reading time. Calculators approved by NESA may be used Reference sheet is provided	Year 11: School based assessment programme includes the following requirements: • 3 assessment tasks • The minimum weighting for an individual task is 20% • The maximum weighting for an individual task is 40% • One task must be an assignment or investigation-style task with a weighting of 20-30% Year 12: • A maximum of 4 assessment tasks • The minimum weighting for an individual task is 10% • The maximum weighting for an individual task is 40% • One task must be an assignment or investigation-style task with a weighting of 15-30% Only one task may be formal written examination with a maximum weighting of 30%	The formal written exam paper will consist of two sections. Section I (10 marks) • 10 questions • Objective-response questions (Multiple choice) Section II (70 marks) • Short answer questions • Multi-part questions • 30 to 35 questions.

[62] New South Wales Education Standards Authority (2018), *NSW Syllabus for the Australian Curriculum: Mathematics Standard Stage 6 Syllabus.*

	Assessment Method (External) and Weighting	Assessment Method (Internal) and Weighting	Use of Question Types
NSW HSC Standard 2 Mathematics[63]	The examination will consist of a written paper worth 100 marks. The time allowed is 2 hours and 30 minutes plus 10 minutes reading time. A reference sheet will be provided. Calculators approved by NESA may be used	Year 11: School based assessment programme includes the following requirements: • 3 assessment tasks • The minimum weighting for an individual task is 20% • The maximum weighting for an individual task is 40% • One task must be an assignment or investigation-style task with a weighting of 20-30% Year 12: • A maximum of 4 assessment tasks • The minimum weighting for an individual task is 10% • The maximum weighting for an individual task is 40% • One task must be an assignment or investigation-style task with a weighting of 15-30% Only one task may be formal written examination with a maximum weighting of 30%	The formal written exam paper will consist of two sections. Section I (15 marks) • 15 questions • Objective-response questions (Multiple choice) Section II (85 marks) • Short answer questions • Multi-part questions • 35 to 40 questions.

63 Ibid.

NSC Mathematics assessment methods involve both internal and external examinations. The externally assessed final examination consists of two papers and is worth a total of 75% of the final mark. The additional 25% comes from the internal assessment, which is obtained through multiple tests, investigation projects, assignments, and examinations across grades 10-12. Question types within the final examination papers are short, multiple-part questions. A formula sheet is provided in all examinations across all programmes.

ZIMSEC and IB Diploma programme's assessment methods are very similar to those of NSC Mathematics. The IB Diploma programmes consists of an external assessment worth a total of 80% of the final mark, which comprises of two examination papers. The final 20% of the total mark consists of an internal assessment that is a piece of written work involving the investigation of an area of mathematics. Question types within the final examination papers are short, multiple-part questions. IB DP is not the only programme to not allow the use of a calculator in paper one of the external examination. ZIMSEC involves continuous internal assessment worth a total of 30% of the final mark. Continuous assessment involves topic tasks, written tests, end of term tests and a project. 70% of the final mark is an external examination consisting of 2 papers worth 35% each.

Cambridge International AS/A Level have different assessment methods to NSC Mathematics, where no internal assessments are included. External examinations occur at the end of the first (International AS) year and the second (International A Level) year. International AS level consists of two papers in the final examination and International A Level consists of four papers. Similar to the Cambridge International AS/A Level, KCSE Mathematics does not include any internal assessments and only requires an external examination at the end of the programme, which consists of two papers.

NSW HSC Advanced, Standard 1 and 2 include an external formal examination at the end of the programme, which consists of one paper. This is accompanied by internal assessments, which occur throughout years 11 and 12. NSW HSC Advanced, Standard 1 and 2 include a different style of questions compared to all other programmes, including NSC Mathematics. Papers consist of two sections, with section one worth a smaller quantity of marks consisting of multiple-choice questions. Section two is worth a much greater number of marks and consists of short, multiple-part questions.

Key Findings

Learning Outcomes and Assessment Objectives

Scope

Different programmes use different terms for learning outcomes and assessment objectives and therefore learning outcomes are not always directly compared with learning outcomes and likewise for assessment objectives. For learning outcomes, NSC Mathematics have labelled these as "specific skills", "Objectives" by ZIMSEC, KCSE Mathematics and NSW HSC programmes and "Assessment objectives" by IB Diploma programmes and Cambridge International AS/A Level. For the assessment objectives, these have been labelled as "Cognitive levels and skills to be demonstrated" by NSC Mathematics, "Assessment objectives" by ZIMSEC, Cambridge International AS/A Level, IB Diploma programmes and "Objectives" by KCSE Mathematics and NSW HSC programmes.

NSC Mathematics uses the learning outcomes to identify the skills that aim to be developed, and the assessment objectives to focus on the use and understanding of topics covered in the syllabus, which include identification and use of correct formula, making significant connections between different representations, estimation and appropriate rounding of numbers, simple applications, and calculations. Similar to NSC Mathematics, the assessment objectives from Cambridge International AS/A Level and ZIMSEC focus on mathematics-based objectives. Both Cambridge International AS/A Level and NSC Mathematics include the ability to recall information as an assessment objective.

Skills Coverage

NSC Mathematics covers a variety of different skills that are presented as learning outcomes, such as: spatial skills, communication, problem-solving, critical analysis, and mathematical process skills. The key similarities that NSC Mathematics exhibit in relation to the other programmes include the outcome focused on the development of problem-solving and communication (IB DP, Cambridge International AS/A Level, KCSE Mathematics and ZIMSEC). For example, from the NSC:

- use spatial skills and properties of shapes and objects to identify, pose and solve problems creatively and critically.

From KCSE:

- comprehend, analyse, synthesise, evaluate and make generalizations so as to solve Mathematical problems.

A second skill that NSC Mathematics has drawn upon is the development of critical analysis skills, this is repeated by KCSE Mathematics as an important skill to develop. This can be shown through the following examples in NSC Mathematics and KCSE Mathematics respectively:

- use mathematical process skills to identify, investigate and solve problems creatively and critically.
- think and reason precisely, logically and critically in any given situation.

Differences that are apparent between NSC Mathematics and other programmes includes the outcome of spatial skills, where there is no mention of spatial skills in any of the other programmes' learning outcomes. Secondly, the use of technology is not referenced within the learning outcomes or assessment objectives for NSC Mathematics, however this is key in IB DP, ZIMSEC and NSW HSC curricula. For example, an outcome from NSW HSC Advanced aims to develop the ability to use advanced mathematical models and techniques, aided by appropriate technology, to organise

information, investigate, model and solve problems and interpret a variety of practical situations.

Content and Structure

Scope

There are many content similarities between the NSC Mathematics curriculum and the comparison points examined. For example, many statistics topics emerge in NSC Mathematics and also feature throughout the international examples. On the other hand, mechanics topics feature strongly in the Cambridge International AS/A Level context, yet this is not offered as a main topic in other curricula, including NSC Mathematics.

The majority of core mathematics topics that are covered in NSC Mathematics were present in most other programmes' curricula – for instance, algebra, functions, analytical geometry, differential calculus and trigonometry. However, Euclidean Geometry and the content within it was not common to other curricula. Statistics and probability, also described as statistical analysis, is covered in NSC Mathematics, which is coherent with the majority of other programmes with the exception of ZIMSEC (which features a separate curriculum focussing on statistics). Similar to NSC Mathematics – KCSE Mathematics, NSW HSC Advanced and Standard 1 and 2 also include finance-based topics. Lastly, it can be noted that KCSE and NSW Standard 1 and 2 did not cover some topics in the same detail as NSC and other programmes.

When looking across the comparison programmes' content, there were some common topics identified that were not present in the NSC. These were integration (present in all except NSW Standard) and vectors (present in all but NSW Standard/Advanced – they are covered in Mathematics Extension instead). Other programmes also tended to include content involving random variables and the binomial and normal probability distributions in statistics, rather than linear regression. Additionally, there were other, less common differences. For example, the "Networks" topic in NSW HSC Standard 1 and 2, the Additional Higher Topics such as "Sets, relations, and groups" in IB DP Mathematics HL, and the mechanics and advanced statistical content in Cambridge International.

Though NSC generally covers topics in similar depth and detail to most other programmes and has complexity in certain topics such as Euclidean Geometry, it can be noted that more areas of complexity can be identified in the content of some other programmes, namely Cambridge International A Level, IB DP HL, and ZIMSEC Forms 5 and 6.

NSC Mathematics includes investigation projects as a method to assess students practical and investigation skills, as do IB DP, ZIMSEC, and NSW Standard/Advanced. Only the IB DP and NSC explicitly state the weighting of assessment criteria for the marking of these tasks, which when compared have a similar focus on communication, presentation, and understanding of the mathematics. Overall, both programmes offer an investigative task which allows for mathematical exploration and can be accessed by all students - whilst having scope for higher-attaining students to produce work showing deeper complexity and understanding. However, it can be noted that where IB has one, extensive project, the NSC have more frequent internal assessments, for which investigations make up a part of.

Sequencing

The CAPS document for NSC Mathematics shows the order in which topics should be taught, term-by-term across the three years of the FET phase, and explains how many weeks should be dedicated to each topic area. This demonstrates a prescriptive approach to sequencing which contains more granular detail than some of the other programmes considered in this report. The sequencing structure displayed in the CAPS document also shows how some topics are raised in the earlier terms and then

revisited (with additional detail) at later points. For example, Trigonometry features as a topic in Grade 10 (terms 1, 2, and 3), Grade 11 (term 2 and 3), and Grade 12 (term 1 and term 2). It would also likely appear in the dedicated revision time put aside for term 4 in each year.

Similar to NSC Mathematics, the IB DP Mathematics, NSW HSC Advanced Mathematics, and Cambridge International AS/A Level Mathematics all introduce functions early on in the content. Alongside functions, algebra is also generally near the start of the syllabus, which is shown in NSC Mathematics, IB DP, KCSE Mathematics, ZIMSEC and NSW HSC Standard 1 and 2.

Skills Coverage

NSC Mathematics uses four cognitive levels to guide all assessment tasks, which are as follows: knowledge, routine procedures, complex procedures, and problem solving. These skills are continuously assessed and therefore applied within topics of the NSC Mathematics curriculum. Due to the similarity of core content across the programmes, the mathematical skills embedded in the content of each programme are very similar. NSC Mathematics includes content on Finance and growth; within this topic, skills that can be developed include critical analysis on different loan options and the application of knowledge of geometric series to solve annuity and bond repayment problems. In comparison, NSW HSC Standard 1 and 2 assess similar skills within the topic financial mathematics, which involves the application of knowledge, skills and understanding of numbers to earning, spending, investing, saving and borrowing money. Other topics in the NSC Mathematics content, such as functions, focus on the development of problem-solving and graph work involving the prescribed functions. IB DP Mathematics includes the topic "functions" and expect that extensive use will be made of technology in both the development and the application of this topic, rather than elaborate analytical techniques.

Within the topic "statistics", students collect, organise, and interpret univariate numerical data. NSC Mathematics uses mathematical problems that cover topics related to health, social, economic, cultural, political and environmental issues to develop problem-solving in real life scenarios. Analysis skills are further developed during statistics, where students use statistical summaries and correlation to analyse and make meaningful comments on the context associated with given bivariate data, including interpolation, extrapolation and discussions on skewness. Similar to NSC Mathematics, IB DP Mathematics SL uses the topic "statistics" to develop skills in the form of collection of raw data and displaying data in various different graphs, charts and diagrams, with a strong emphasis on understanding and interpreting the results obtained. This is further repeated by KCSE Mathematics, Cambridge International AS/A Level, NSW HSC Advanced and Standard 1 and 2.

The unique topic Networks included in the NSW HSC Standard 1 and 2 content encourages students to develop their awareness of the applicability of networks throughout their lives, for example, social media networks, and their ability to use associated techniques to optimise practical problems.

Assessment

Structure

NSC Mathematics has both internal and external assessment methods. The internal assessments are continuous throughout grades 10-12, which contribute a total of 25% to the final mark. Internal assessments include investigation or projects, tests, assignments and examinations. Different to NSC Mathematics, KCSE Mathematics and Cambridge International AS/A Level are the only programmes that do not include any internal assessments.

The NSC external assessment is in the form of a final examination, consisting of two papers,

worth a total of 75% of the total mark. Four cognitive levels are used to guide all assessment tasks as the following: knowledge, routine procedures, complex procedures and problem solving. Both external examination papers consist of short, multiple-part questions, which is similar to the majority of other programmes. NSW HSC Mathematics programmes differ as each examination paper includes a combination of multiple-choice questions and short, multiple-part questions.

All programmes vary regarding the total number of marks for external assessments. In general, the majority of programmes have two examination papers, where individual examination papers require a time between two and three hours to complete the assessment, which is comparable to the NSC. The main difference is NSW HSC Mathematics programmes, which only require one formal external written examination.

IB DP Mathematics SL and HL are the only programmes to not allow calculators in an external examination paper. All other programmes, including the NSC, allow calculators and provide an information/ formulae sheet in the external examinations.

Marking

Mark schemes were compared from NSC Mathematics, IB DP Mathematics, NSW HSC Mathematics, KCSE Mathematics, and Cambridge International AS/A Level.

The NSC Mathematics mark scheme is consistent across all examinations, where marks are awarded for appropriate use of equations, method marks, and reaching the correct answers. The maximum number of marks for a question was noted as six.

IB DP Mathematics mark schemes award marks for answers or for accuracy, reasoning and correct answers with no working shown. Follow-through marks are also awarded if the wrong answer has been carried forward from a previous sub-question, for example when information is incorrectly copied from the question, resulting in a wrong final answer, which is also shown Cambridge International AS/A Level mark schemes. Mis-read marks are also given to students when information is incorrectly copied from the question, resulting in a wrong final answer. The NSC also supports this form of marking and has named this principle "Consistent Accuracy". More specifically, in the NSC Mathematics Exam Guidelines it is outlined that "Consistent Accuracy marking regarding calculations is followed in the following cases: 1) Sub-question to sub-question: when a certain variable is incorrectly calculated in one sub-question and needs to be substituted into another sub-question full marks can be awarded for the subsequent sub-questions provided the methods used are correct and the calculations are correct; 2) Assuming values/answers in order to solve a problem is unacceptable". Similar to the IB DP, Cambridge International AS/A Level, KCSE Mathematics and NSW HSC programmes award marks for "accuracy".

NSW HSC mark schemes award single marks for correct answers during the multiple-choice questions. For the short, multiple-part questions, Correct solutions, correct rounding and method marks are awarded.

Different to NSC Mathematics, grade descriptors are used in the IB Diploma programmes. Grades range from the highest level 7 to the lowest level 1. Senior examiners use these grade descriptors when determining grade boundaries for examination papers and coursework components. In order to achieve grade 7, students must demonstrate a range of mathematical skills such as the following: successfully construct and apply mathematical arguments; successfully use problem solving techniques in challenging situations; recognize patterns and structures, understand and explain the significance and validity of results; communicates mathematics in a clear, effective and concise manner, using correct techniques, notation and terminology. Lower grades, for example grade 1, are awarded to students that demonstrate little or no ability to

use mathematical processes; communicate only minimal mathematics and consistently use inappropriate techniques, notation or terminology.

Skills Coverage

Questions in both Papers 1 and 2 of the NSC Mathematics external examinations aim to assess performance at different cognitive levels with an emphasis on process skills, critical thinking, scientific reasoning and strategies to investigate and solve problems in a variety of contexts.

NSW HSC Mathematics programmes are the only programmes with a different style of assessment questions in the examinations in the form of multiple-choice questions. The most common questions that occur across examinations include calculation questions, where students are required to show their working and demonstrate their understanding of the questions and apply their mathematical skills. Both internal and external assessments required in the NSW HSC Mathematics programmes test the following skills: understanding, fluency and communication, problem-solving, reasoning and justification.

The quantity of questions and sub-questions in each examination are similar across all of the programmes.

Programmes that include internal assessments are NSC Mathematics, ZIMSEC, IB DP, NSW HSC Advanced, Standard 1 and 2.

IB DP documentation articulates that internal assessments are used to enable students to demonstrate the application of their skills and knowledge, and to pursue their personal interests, without the time limitations and other constraints that are associated with written examinations.

All programmes award method marks in external examination papers, therefore students are encouraged to show their workings and use a logical approach to solving each problem. For example, IB DP SL states that answers must be supported by working and/or explanations (in the form of, for example, diagrams, graphs or calculations). Where an answer is incorrect, some marks may be given for correct method, provided this is shown by written working.

Documentation

For details of the subject guides, assessment materials, and mark schemes used throughout this appendix (including years of publication), see **7. Bibliography** in the body of the report.

Notes

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