Malaysian Independent Chinese Secondary Schools

Senior Middle Level
Advanced Mathematics
Curriculum Standards

Compiled by:

Unified Curriculum Committee of
Malaysian Independent Chinese Secondary School
Working Committee

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Contents

1. Preface

In 2018, the motto "Enjoy teaching, love learning—empower children to attain achievement" was raised as the education reform vision in the *MICSS Education Blueprint*; it literally translates independent Chinese secondary schools are paradises where teachers enjoy teaching and students love learning. Each and every student who steps into any independent Chinese secondary school will grow healthily and learn actively. The MICSS education prepares students to find a foothold domestically and brave the world lying ahead as it helps them to achieve success in the future. Within this vision, the main objectives of the MICSS education reform are as follows: Every student is given the leeway to develop holistically and individually under the umbrella of moral education, intellectual education, physical education, social education and aesthetics education. They will eventually realise the importance of lifelong learning, constant self-improvement, risk-taking, innovation, ever-readiness, self-confidence and teamwork in life. In this way, they are able to attain personal happiness and are willing to strive for harmony, prosperity, development, freedom and equality for their family, ethnic group, community and country and contribute themselves successively. Aiming to implement and put the vision and objectives raised in the *MICSS Education Blueprint* in place, the Unified Curriculum Committee forwarded the *MICSS Main Curriculum Standards* (simply put as the *Main Standards*) to concretely push the reform and development of the MICSS Curriculum forward.

The ultimate goal of the MICSS curricular reform is the production of "lifelong learners" and thus it endeavours to improve subject curriculums to provide cross-subject and interdisciplinary learning opportunities. These are to nurture self-activated learning, collaborative learning and the ability to participate in society naturally. The curriculum standards of each subject are designed amenable to the principles and direction set forth in the *Main Standards* to pursue the command of basic notions, objectives, competencies, curricular planning and contents of the subjects, let alone pedagogical approaches and assessment recommendations. In terms of curricular practice, there will be allowances for flexibility and options targeting to encourage group learning, task-based learning, inquiry-based learning, etc.; while in the matter of the assessment for learning effectiveness, multiple assessments for the development of multiple intelligences are adapted. As such, the design and formulation of each and every subject must correspond to both the vision of the *MICSS Education Blueprint* and the recommendations of the *Main Standards* to break new ground for subject advancement.

2. Aims

MICSS education is a sustainable education industry; other than the dissemination of Chinese culture, it also ensures every student in Malaysian independent Chinese secondary schools develops holistically in terms of morality, intelligence, physical health, teamwork and aesthetics. Students are expected to sustain lifelong learning and to strive unremittingly for self-improvement as well as being inquiry-oriented, innovative, daring in response to unpredictable change, confident, and willing to work as a team. In this way, the students are capable of achieving their personal happiness and willing to strive relentlessly for the harmony, prosperity, development, freedom and equality of their family, ethnic group, community and country to contribute successively.[1]

[1] Dong Zong. (2018). *Malaysian Independent Chinese Secondary Schools Education Blueprint* (p. 49). United Chinese School Committees' Association of Malaysia (Dong Zong).

2.1. Junior Middle Level Curriculum Objectives

a. To build up students' foundation on morality, intelligence, physical health, teamwork and aesthetics and to develop their capabilities complying with their own personality in the balance based on these basics;
b. To nurture and train students on the capabilities and habits of learning how to learn, read and think to prepare for self-directed learning/active learning;
c. To ensure students reach the basic level in knowledge, capability and attitude so as to further unleash their potential for distinctive achievements;
d. To build up students' proactiveness and positive values towards living and life; and
e. To create an environment for students to know about the languages, cultures and religions, etc. of the ethnic groups in the country so as to lead students to respect the pluralistic culture, recognise the reality of the country thus opening up a global perspective.

2.2. Senior Middle Level Curriculum Objectives

a. To suitably build up students' foundation on morality, intelligence, physical health, teamwork and aesthetics to get ready for their prospective, career, learning and living;
b. To establish students' foundation on self-directed learning to further build up their capabilities on learning eagerness, independent thinking, critical thinking and innovation;
c. To cultivate students with the will to seek excellence and be altruistic thus creating the prerequisites for greater happiness for oneself, community, country and humankind;
d. To lead students to recognise themselves comprehensively and be confident and assured in the face of their society and era change;
e. To nurture students' responsibility towards their own family, ethnic group, society and country and respect multiple cultures as well as broadening their global perspectives; and
f. To create opportunities for students to partake proactively in various ethnic group activities, and ensure them to be able to interact and learn in cross-cultural environments.

3. Core Competencies

The *Main Curriculum Standards* is based on the six core competencies[2] proposed in the *MICSS Education Blueprint*, as well as three additional core competencies added to cater to curriculum development needs, forming a total of nine core competencies. Further explanation is given in the design of Junior Middle Level and Senior Middle Level curriculum development. Core competencies emphasise the holistic qualities of individuals and encompass knowledge, skills and attitudes.

[2] Dong Zong. (2018). *Malaysian Independent Chinese Secondary School Education Blueprint* (pp. 40-41). United Chinese School Committees' Association of Malaysia (Dong Zong).

Figure 1

Framework for MICSS Core Competencies

Figure 1 shows that MICSS curriculum development cultivates lifelong learners. The structure expanded into three aspirations that empower children to attain achievement, namely self-directed learning, communication and collaboration as well as societal participation. The outer ring of the core competency structure is presented in a colour spectrum, revealing the integration of nine competencies with the three aspirations. The misalignment of the inner and outer circle further clarifies that the implementation of each competency incorporates the three major aspirations. Based on the principle of integration and feasibility, the Main Curriculum Standards promote each competency through three aspirations. Table 1 presents the core competencies and their definitions.

Table 1

MICSS Core Competencies and Definitions

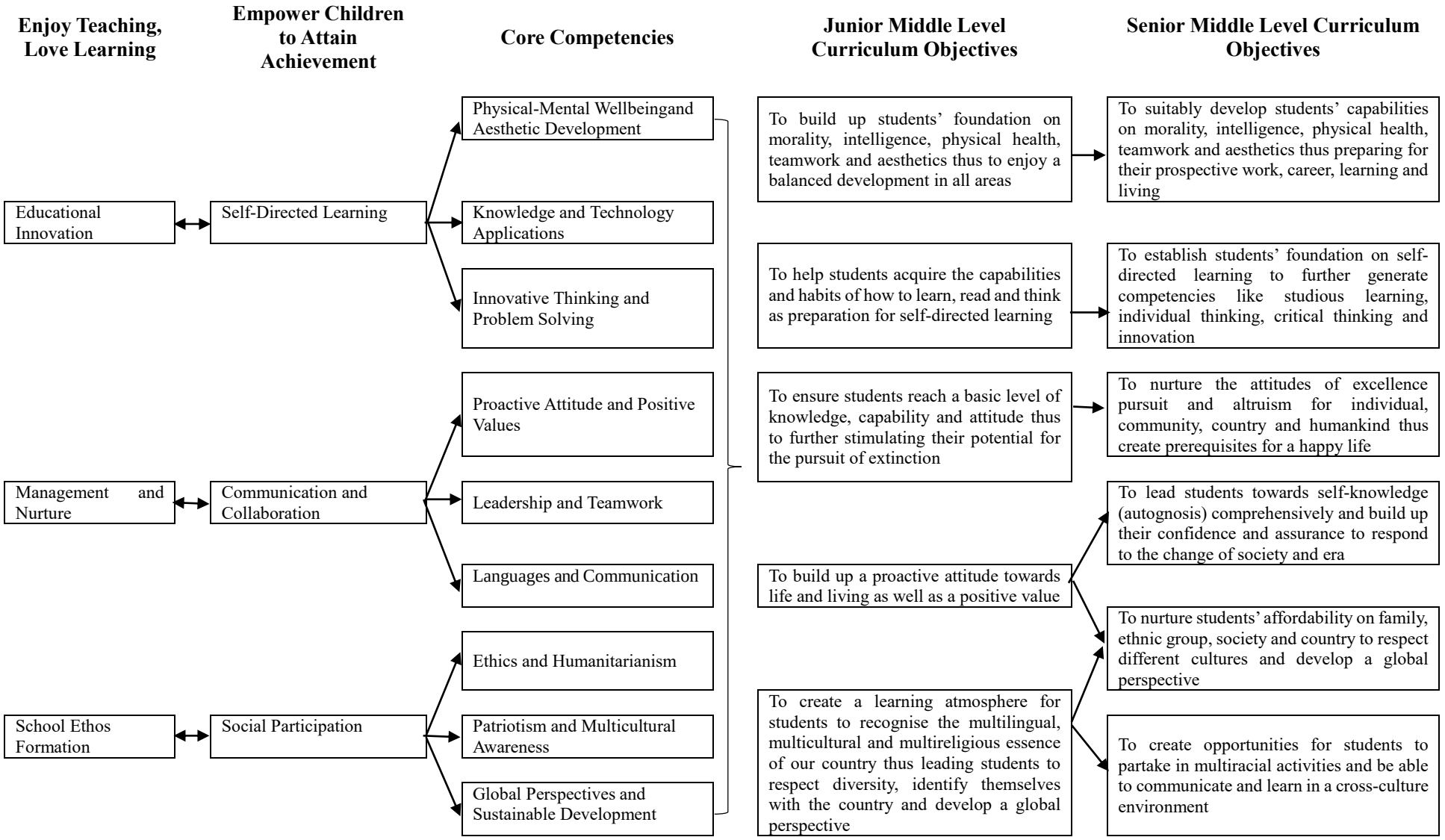
Curriculum Principle	Core Competencies	Definitions	Junior Middle Level	Senior Middle Level	Student Outcome
A. Self-Directed Learning	A1. Physical-Mental Wellbeing and Aesthetic Development	She/He possesses the capability to take care of personal mental and spiritual health and knows how to appreciate the best parts in life, and can reflect on her/his experience in learning and growing thus adjusting stages of pursuits in career development. This way, it not only benefits mental and spiritual growth but also exerts proactiveness in creating happiness for her/his own life.	She/He is well informed of personal mental and spiritual health, knows the uniqueness of aesthetics and can discover personal value in living to exert richness and aesthetics thus experiencing the meaning of life proactively.	She/He possesses the competency and is informed of the approaches to promote her/his physical and mental wellbeing; she/he knows how to appreciate the true goodness of people and entities, affirm the personal value and realise professional pursuits, including how to enrich life by applying aesthetics in daily life, and relentlessly seek self-improvement to transcend herself/himself thus to create a happy personal life.	One who cares about herself/himself
	A2. Knowledge and Technology Applications	She/He possesses literacy and numeracy and living skills as well as acquiring the three languages, core subjects like Mathematics and History, etc. She/He knows and learns knowledge of other domains, leverages Information Technology to communicate, interact and express for comprehensive development; meanwhile, she/he applies these in real life for better learning outcomes thus resolving difficulties in learning.	She/He possesses the fundamentals of knowledge and various symbols and commands the application of Information Technology to sense problems in daily life and is able to communicate, experience and practice in such circumstances.	She/He possesses the ability to make use of various symbols to express and is literate in Information Technology and can focus on and deepen the particular field of knowledge to exchange experience, and express thoughts and values in innovative problem-solving.	One who is knowledgeable
	A3. Innovative Thinking and Problem Solving	She/He possesses inquisitive, critical and inferential capabilities and can use her/his creativity to monitor her/his self-directed learning skills to tackle or solve problems in living and life thus deciding on a response to societal changes.	She/He possesses the capabilities of self-directed learning, inquiry-based learning, critical and inferential and innovative higher-order thinking thus using appropriate strategies to resolve and tackle daily life problems and issues.	She/He can consolidate inquiry-based learning, critical thinking and innovative higher-order thinking, and can practise active learning as well as expressing her/his creativity to further inquire into unknown realms and solve all sorts of issues and challenges in the face of daily life on this basis.	One who can solve problems

Curriculum Principle	Core Competencies	Definitions	Junior Middle Level	Senior Middle Level	Student Outcome
B. Communication and Collaboration	B1. Proactive Attitude and Positive Values	She/He possesses values like respect, voluntary accountability, studious and positive values to confront challenges generated in daily life and the learning process. She/ He also recognises the importance of fulfilling social responsibility and has the courage to make a clear and appropriate judgement when confronted with dilemmas and can learn to face discrepancies as well managing conflicts.	She/He inquires about the personal and environmental values and senses the discrepancies between them. She/He learns to live with discrepancies and build up respect, responsibility, studious attitudes and positive value in life.	She/He deepens her/his attitudes and values thus to respect, care and appreciate others' discrepancies, and can fumble on the differences of values between oneself and the existence and learn to tackle confrontation, affirm and practise positive value and competency; she/he braves to make a proper judgment in the face of difficulties and challenges.	One who cares about others
	B2. Leadership and Teamwork	She/He possesses the capability to lead and can effectively work and build up an interactive relationships with others thus developing teamwork competencies of communication, negotiation and service.	She/He possesses the basic self-directed capability and good habits and is happy to interact thus building up good collaborative relationships and can complete tasks through collaboration.	She/He possesses compassion, personal judgment, gregarious capability and attitude; meanwhile, she/he develops communicative co-operation and teamwork competency; she/he can get along well with others collaboratively, and is able to complete the assignment well with advanced planning.	One who knows the importance of teamwork
	B3. Languages and Communication	She/He possesses the background knowledge of culture, tradition and religion and can make use of Chinese learned, together with the command of Bahasa Melayu towards patriotism and love for community and is versed in English for international linkage. When it permits, she/he will master more languages and use these languages in different situations for optimal effect.	She/He possesses the background knowledge of culture, tradition, religion and can make use of Chinese learned, together with the command of both Bahasa Melayu and English to make friends from different ethnic groups thus enhancing the four skills in language learning and eventually realise the importance of language as a medium of cultural dissemination and communication.	She/He is well versed in Chinese and possesses appreciative competency to enrich her/his knowledge of local and exotic cultures, lifestyles and religions through the learning of Bahasa Melayu and English. If it permits, she/he will equip herself/himself with more additional languages in the face of academic pursuits and professional development.	One who is skillful in communication

Curriculum Principle	Core Competencies	Definitions	Junior Middle Level	Senior Middle Level	Student Outcome
C. Social Participation	C1. Ethics and Humanitarianism	She/He practices good morality and can manage her/his own behaviours and understand that it is a social responsibility to promote personal competencies. She/He can appreciate, is compassionate and respect others for their freedom of speech.	She/he practices well on good morality and can suitably reflect her/his own behaviours; she/he can likewise sustain and modify her/his initiated voluntary proactiveness and is willing to listen to different views, ways of expression and respect others' decisions.	She/He possesses the correct attitude towards ethical and public issues and presents herself/himself as someone who treats others generously and is severe with herself/himself and expresses her/his care towards society through rational expression and care and learns to judge public issues from different aspects and angles.	One who is open-minded
	C2. Patriotism and Multicultural Awareness	She/He possesses the cultural identity of her/his own culture, understands and respects others' culture thus merging herself/himself in a multicultural environment, recognise the history of her/his country and realise the multiplicity of the country and is proud of herself/himself as a Malaysian who has civic awareness and responsibility safeguarding the harmony of the country for national unity and integration.	She/He is well versed in her/his own culture, understands and accepts the culture of other ethnic groups; she/he respects discrepancies, cares about national issues, and is proactive in community construction and is ready to be of service to others.	She/He identifies her/his cultural identity, respects and appreciates the discrepancies between cultures; she/he has civil awareness and knows her/his responsibilities; she/he safeguards national harmony and promotes the spirit of national consolidation and is proactive in the development of her/his community and country to confer benefits on society.	A patriot and one who loves her/his community
	C3. Global Perspectives and Sustainable Development	She/he has the competency of caring for world issues and international relationships and also cares about the environment, economics and social problems. She/He walks her/his talk in the protection of the environment, her/his and others' living mode and sustains the concept of sustainable development and cherishes resources on earth.	She/He is informed of global issues and international relationships and can express herself/himself on environmental, economic and social problems. She/He cherishes the living of resources appreciation and cares about the environment and social justice-related issues.	She/He possesses the ability to express her/his own views on global issues and international relationships and can debate on the environment, economy and social problems; She/He can keep her/his word and not bring harm to the environment, people and lifestyle; she/he is willing to partake charity campaigns such as environmental protection and social justice.	One who knows the importance of sustainable development

Figure 2

The Relation of Vision, Core Competencies and Curriculum Objectives



4. Fundamental Principles

The mission and objective of "the Main Standard" are to visualize the vision of "Enjoy teaching, love learning - empower children to attain achievement", implement the overall objectives of MICSS Education Blueprint, and encourage the development of well round and personal characters of students. Mathematics is a language, a subject wherein it applies in a wide range and is also closely related to humanities.Therefore, the mathematics curriculum standards with the curricula contents closely attach to the characteristics of the visions, are responsive to the visions in "General Outline", offer contextual learning opportunities, and cultivate students informatics and communications technology(ICT) competencies. The concepts are described below:

1. Mathematics is a language

The origin of mathematics is related to calculation, measurement, trading, etc. It is refined from natural languages and exemplifies the idea of simplification. Thus, mathematics is a key enabler to our civilization.

Numbers, shapes, spaces, and their interrelation in daily life, can be described more simply and concisely, via text and symbols. The succinctness of mathematical language enables complicated phenomena and relationships to be described in simple yet concise formulae or theories. The accuracy of mathematical language compensates for the inadequacy of natural language moderately. Because of this, mathematics teaching should be conducted by mathematical operation and explanation of examples before teaching abstract concepts.

2. Mathematics applies in a wide range

Mathematics is a field of study that investigates topics such as numbers, space, structure, change, and information. Mathematics is used in daily life, exploration of natural phenomena, interpretation of social phenomena, analysis of fiscal problems, development of sciences, etc. It is a fundamental tool in handling or analyzing problems in the mentioned fields. There is a variety of examples of applying mathematics, such as ratio applied in currency exchange; factorization of large integers in encryption system; numeral system in ASCII code table; the principle of indices in the calculation of compound interest; logarithm in the calculation of half-life of radioactive elements or pH values of solutions; trigonometry in measuring calculation; trigonometric functions are conducive in studies of waves; statistics in commercial investments, actuarial science, biology, and social sciences; calculus in applied economics, etc.

3. Mathematics contains rich humanistic spirits

Mathematics is one of the integral parts of human culture. Rigorous mathematical reasoning or statement of definition and theorem, diversity of problem-solving steps, and well-founded mathematical proofs cultivate not only a disciplined mindset and creativeness, yet pursuit of truth, objective and fair, factual philosophy of life. Mathematical beauty displayed in rational, symbolic, structural ,and symmetrical aesthetics parts enhances students' cognition and experience of aesthetic values. Biography and contribution of mathematicians, the history of mathematics and the culture of mathematics, expose students to the background and development of mathematical knowledge, making the wonder of mathematics accessible to them. Students will realize that the discoveries in mathematics are the outcomes of determination and devotion to mathematics, cultivating their rational mindset and positive attitude imperceptibly.

4. Mathematics teaching should provide contextual teaching

Mathematics teaching should start with a class opener based on real life, the history of mathematics or social issues, followed by learning tasks, with the guidance of teachers to solve problems via exploration, group discuss and collaboration, in order to help students in conceptualizing knowledge of mathematical concepts and developing required skills. Through sharing problem-solving strategies and listening to others' thoughts, students are practicing self-reflection learning, enhancing cognitive and comprehensive learning of the content. Furthermore, this enables students to sense the ubiquity of mathematics in our life and appreciate the wonder and function of mathematics. This teaching method integrates different levels of students with a diversity of learning opportunities.

5. Mathematics teaching cultivates students' ICT competencies

Informatic and communications technology tools, including computers and software, are playing an auxiliary role in mathematics teaching in 21-century. Incorporating of ICT usage into Mathematics Curriculum enables learning content to correspond reasonably with our everyday lives and social context. After students manage to master calculation, in order to a avert repetition of calculation rendering lack of motivation, students should be allowed to use computer or ICT tools appropriately to implement complicated calculations of numbers, statistics, exponents, logarithms, and trigonometric ratios. Nevertheless, computational errors may occur,and students should be reminded so that students understand the occasion and limitations toward using ICT tools in order to promote proper attitudes in ICT usage.Furthermore, integrating computer software into classroom teaching will foster the design and implementation of exploring and monitoring experiments, group discussion and similar pedagogies, thereby promoting growth of intellectual and innovation consciousness.

5. Curriculum Objectives

Advanced Mathematics is competency oriented, emphasizing the development of knowledge, competencies, and attitude for adaptation to current and future life. It comprises three concepts: "self-directed learning", "communication and collaborative", and "societal participation" under the umbrella of the vision "Empower Children to Attain Achievement". Table 2 indicates correspondence table mapping curricular objectives and core competencies.

Table 2: Alignment of MICSS Core Competencies and Curriculum Objectives

Core Competencies		**Curriculum Objectives** After completing the Advanced Mathematics programme, students are able to:	
A Self-Directed Learning	A1 Physical-Mental Wellbeing and Aesthetic Development	CO1	Possess the competency to promote her/his physical and mental competencies; know self-directed learning; know how to appreciate the true goodness and beauty of people and entities; understand that mathematics has influenced arts.

	A2 Knowledge and Technology Applications	CO2	Possess the ability to apply mathematical knowledge and language in real life and leverage Information Technology to resolve and tackle problems, while also knowing the limitations of scientific tools.
	A3 Innovative Thinking and Problems Solving	CO3	Possess the ability to transform daily life situations into mathematical context, while she/he can solve all sorts of issues and challenges by choosing and implementing flexible tactics.
B Communication and Collaboration	B1 Proactive Attitude and Positive Value	CO4	Deepen her/his attitudes and consolidate her/his confidence in mathematical learning; conduct self-directed learning; be brave to make proper solutions in the face of difficulties and challenges.
	B2 Leardership and Teamwork	CO5	Possess empathy, gregarious capability, and attitude; can get along with others collaboratively and develop communicative co-operation and teamwork competency via mathematical learning activities; meanwhile, complete tasks well with advanced planning.
	B3 Language and Communication	CO6	Possess the ability to master mathematics knowledge in Chinese and articulate in mathematical language; meanwhile, learning mathematical terms in Bahasa Melayu and English in the face of academic pursuits and professional development.
C Societal Participation	C1 Ethical and Humanitariansim	CO7	Possess the ability to promote her/his critical and reflective thinking; learn to express concerns to and judge public issues from different aspects and angles.
	C2 Patriotism and Multicultural	CO8	Possess the ability to analyze national and society issues, have the competency of caring for these issues, and thus become a rational citizen. In addition, understand the context of mathematical history and appreciate mathematical culture from various regions.
	C3 Global Perspectives and Sustainable Development	CO9	Understand the future of mathematical, scientific, and technological development; concern herself/himself with societal and sustainable environmental development issues.

6. Curriculum Design

6.1 Design outline

The essence of mathematics is hierarchical: from elementary counting to an advanced abstract mathematical concepts. The formation of mathematical concepts requires a series of deepening and expanding progress, from simple to sophisticated, concrete to abstract. In other words, higher-level mathematical concepts and competencies are based on elementary concepts and competencies, thus learning mathematics proceeds by small incremental advances.

Mathematics (Senior Level, or S.L.)for senior secondary schools is based on Mathematics (Junior Level, or J.L.), extends to algebra, geometry, statistics and probability, three domains of the subject, and eventually integrates differentiation and integration into it. The spiraling nature of the curricular arrangement is conducive to embedding learning points from various fields. The learning points will become more intensified and extended with level. Senior One mathematics focuses on geometry, algebra and subsequent advanced trigonometry; Senior Two on advanced algebra, geometry, statistics and probability; Senior Three introduces calculus, and subsequent integration of calculus with algebra, geometry, trigonometry, statistics and probability. Mathematics(S.L.) is taught in the art stream, commerce stream, art and commerce stream, and vocational stream. Thus, apart from demonstrating mathematical logic, Mathematics(S.L.) is also partially based on applied mathematics.

Advanced Mathematics is taught in the science stream. Thus, it comprises Mathematics(S.L.) syllabus and extension of differential equations, mathematical methods, conic sections, complex numbers, and vector space which are more abstract, laying the foundation of applied mathematics and theoretical mathematics.

6.2 Period allocation

There are 40 weeks of teaching in an academic year for Senior One, Senior Two, and Senior Three. Senior One and Senior Two 7 periods every week, while Senior Three 5 periods every week. Each period lasts for 40 minutes.

Table 3: Advanced Mathematics Curriculum Timetable

Catetgory	Discipline	Subject	Senior Middle One Class Period per week	Senior Middle Two Class Period per week	Senior Middle Three Class Period per week	Total period per week
Dong Zong Curriculum	Science	Advanced Mathematics	7	7	5	7 x 2 x 40 + 5 x 40 = 760 periods

6.3 Subject Structure

Senior level mathematics is divided into Mathematics(S.L.) and Advanced Mathematics to meet the learning requirements of arts, commerce, technical and science streams.

Mathematics(S.L.) is based on Mathematics(J.L.), and it is coherent. Mathematics(S.L.) is a subset of Advanced Mathematics; thus all senior students should commit themselves to learning it.

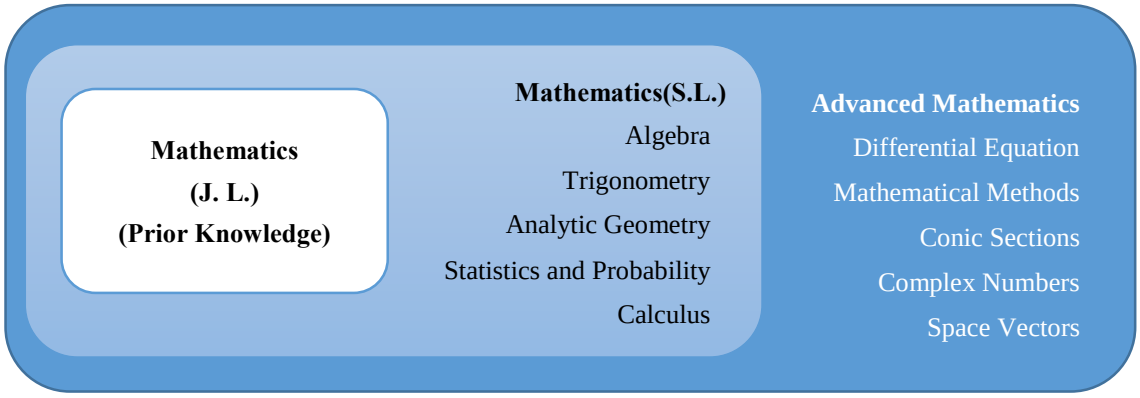


Figure 3: Subject Structure of Mathematics

7. Curriculum Content

7.1 Content Standards

Table 4

Content Standards

Theme	Item	Details
1. The Cartesian Coordinate System and Linear Equations	1.1 Formula of Divisor of Line Segment	1.1.1. Meaning of fixed ratio point of divisor
		1.1.2. Meaning of midpoint formula
		1.1.3. Meaning of divisor ratio formula
	1.2 Area of Triangles and Poligons	1.2.1. Finding the area of triangle and polygon by vertices
	1.3 Gradient of Straight Lines	1.3.1. Definition of angle of inclination and slope
		1.3.2. Linear equations (point-slope form, standard form) under given conditions.
		1.3.3. Conditions of two parallel and perpendicular lines
		1.3.4. Relationship between two straight lines (parallel, perpendicular, coincident, intersecting)
	1.4. Distance Between Point and Line	1.4.1. Definition of distance between point and line
		1.4.2. Formula of finding distance between point and line
2. Quadratic Equations	2.1. Discussion on Quadratic Equations	2.1.1. Nature of quadratic equations
		2.1.2. The discriminant of quadratic equations

		2.1.3. The relationship of roots and coefficients of quadratic equations
	2.2. Graphs and the Extreme Values of Quadratic Equation	2.2.1. Quadratic functions in $a(x-p)^2+q$
		2.2.2. Graph, direction of the opening of parabola, axis of symmetry, maximum or minimum value of quadratic functions
		2.2.3. Meaning of roots of quadratic equations
		2.2.4. Discriminant for finding number of intersection points
		2.2.5. Finding extreme value in quadratic functions $y=a(x-p)^2+q$
		2.2.6. Transformation of graphs $f(x)=ax^2+bx+c$
3. Polynomials	3.1. Polynomials	3.1.1. Degree, coefficient, leading coefficient, constant term of polynomials
		3.1.2. Arithmetic and synthetic division of polynomials, meaning of factorization and multiplication in polynomials
	3.2. Remainder Theorem and Factor Theorem	3.2.1. Remainder Theorem and Factor Theorem
		3.2.2. Finding remainder or factor from given conditions
		3.2.3. Finding polynomial from given remainder or factor
	3.3. Factorization of Polynomials	3.3.1. Factorization of polynomial
		3.3.2. Factorization by Factor Theorem
	3.4. Solve Quadratic Equations with Higher Order	3.4.1. Higher-order equations in one variable
		3.4.2. Solving specific quadratic equations with higher order by substitution
4. Irrational Expression	4.1 Radical Equations	4.1.1. Meaning and nature of radical equation
		4.1.2. Simplifying radical with different Indices
	4.2. Fractional Exponents	4.2.1. Definition of fractional exponent
		4.2.2. Arithmetic operations in power
		4.2.3. Simplifying radical expressions with fractions

		4.2.4. Fulfilling requirements for simplest radical form
		4.2.5. Simplifying radicals to the simplest form
	4.3. Arithmetic of Radicals	4.3.1. Arithmetic of radicals
		4.3.2. Multiplying and dividing radicals by fractional exponents
	4.4. Rationalizing Fractions and Denominators	4.4.1. Meaning of rationalize fractions and denominators
		4.4.2. Rationalizing the denominators in the form of $\sqrt{a} \pm \sqrt{b}$
5. Functions	5.1. Functions	5.1.1. Definition of correspondence and mapping
		5.1.2. Definition of function, independent variable, dependent variable
		5.1.3. Function notations (piecewise function, analytic method, table method, graphical method)
	5.2. Domain and Range of Functions	5.2.1. Meaning of domain and range
		5.2.2. Domain and range of functions
		5.2.3. Concept and notation of interval, conversion between sets and interval notations
	5.3. Image of Functions	5.3.1. Meaning of graph of function
		5.3.2. Graph and nature of elementary functions (constant function, linear function, quadratic function, absolute value function, reciprocal function)
		5.3.3. Graph of a function and its transformation
	5.4.1 Composite Functions	5.4.1. Meaning of composite function
		5.4.2. Composite functions and their calculations
	5.5. Bijection Functions	5.5.1. Meaning of one-to-one function, surjection function, bijection function
		5.5.2. Determination of one-to-one functions, surjection functions, bijection functions
	5.6. Inverse Functions	5.6.1. Meaning of inverse function, and its domain and range
		5.6.2. Finding and arithmetic of inverse functions

		5.6.3. Graphic meaning of inverse functions
6. Inequalities	6.1. Inequalities and Their Nature	6.1.1. Concept of inequality
		6.1.2. Nature of inequality
		6.1.3. Comparison of two inequalities
	6.2. Quadratic Inequalities	6.2.1. Quadratic inequalities
		6.2.2. System of quadratic inequalities
	6.3. Linear Inequalities in Two Variables	6.3.1. Solving linear inequalities by graphical method
		6.3.2. Solving system of linear inequalities in two variables by graphical method
		6.3.3. Graphical meaning of linear inequality
	6.4. Higher Order Inequalities and Rational Inequalities	6.4.1. Higher order inequalities
		6.4.2. Fraction inequalities
	6.5. Inequalities With Absolute Value	6.5.1. Inequalities with absolute value
	6.6. Linear Programming	6.6.1. Meaning of linear programming
		6.6.2. Problems solving of linear programming
7. Logic	7.1. Proposition	7.1.1. Meaning of proposition, rejection, “Or”, and “And”
		7.1.2. Inferencing
	7.2. Condition Proposition	7.2.1. Meaning of necessity condition, sufficiency condition, necessity and sufficiency condition
	7.3. All and Exist	7.3.1. Meaning of “All”and “Exist”
		7.3.2. Simple proof based on given conditions
8. Degree and Radian	8.1. Angles	8.1.1. Arbitrary angles
		8.1.2. Meaning of degree and radian
		8.1.3. Conversion between degree and radian
	8.2. Arc Length and Sector Area	8.2.1. Arc length formula and sector area formula
		8.2.2. Problems solving of arc length and sector area
9. Trigonometric Functions of Arbitrary Angles	9.1. Trigonometric Functions of Arbitrary Angles	9.1.1. Definition of quadrant, acute angle, trigonometric functions of arbitrary angles
		9.1.2. Negative and positive values of trigonometric functions of arbitrary

		angles
		9.1.3. Problems solving with trigonometric functions of special angles
	9.2. Induced Formulas of Trigonometric Functions	9.2.1. Without using calculator, values of trigonometric functions of $360° \pm \theta$, $180° \pm \theta$, $-\theta$, $90° \pm \theta$, $270° \pm \theta$ and relationships with values of trigonometric functions of θ
	9.3. Graph of Trigonometric Functions	9.3.1 Graph of trigonometric functions and their nature (domains, ranges, and periods)
		9.3.2. Graph variations of trigonometric functions
	9.4. Inverse Trigonometric Functions	9.4.1. Definition and range of inverse trigonometric functions
		9.4.2. Graphs of inverse trigonometric functions and its nature
10. Application of Trigonometry	10.1. Law of Sine	10.1.1. Law of Sine
		10.1.2. The circumradius of a cyclic polygon
	10.2. The Law of Cosine	10.2.1. The Law of Cosine
	10.3. Formulas for Area of Triangle	10.3.1. Formulas for Area of Triangle (Area $= \frac{1}{2}ab\sin C$, Heron's Formula)
	10.4. Measurement Problems	10.4.1. Definition of angle of elevation, angle of depression and bearing
		10.4.2. Problems solving with triangle measurements in geometric plane
11. Trigonometric Identities and Trigonometric Equations	11.1. Fundamental trigonometric identities of trigonometric functions	11.1.1 Reciprocal relation, quotient relation and square relation in trigonometric functions of coterminal angles
		11.1.2. Proof of Trigonometric Identity
	11.2.1. Sum and Difference of Two Angles in Trigonometric Functions	11.2.1. Simplifying trigonometric functions (sum and difference of two angles - sine, cosine, tangent) and proof of trigonometric identities
		11.2.2. Simplifying double angle formulas of trigonometric functions and proof of trigonometric identities
	11.3. Trigonometric	11.3.1. Trigonometric equations

	Equations	(conditional solution)
		11.3.2. Trigonometric equations (general solution)
12. Indices and Logarithms	12.1. Exponential Functions	12.1.1. Nature and arithmetic of exponential functions
		12.1.2. Graph of exponential functions and nature of the graphs
	12.2. Logarithmic Functions	12.2.1. Definition, nature and arithmetic of logarithmic functions
		12.2.2. Formula of changing bases for logarithm
		12.2.3. Graph of logarithmic functions and its nature
	12.3. Exponential and Logarithmic Equations	12.3.1. Exponential equations
		12.3.2. Logarithmic equations
13. Sequence and Series	13.1. Sequences and Series	13.1.1. Definition of terms and number of terms
		13.1.2. Applying symbol $\sum$ to represent series
	13.2. Arithmetic Sequences and Arithmetic Series	13.2.1. First term and common difference of arithmetic sequences
		13.2.2. Formulas for general term of arithmetic sequences
		13.2.3. Definition of arithmetic mean
		13.2.4. Summation of arithmetic series
	13.3. Geometric Sequences and Geometric Series	13.3.1. First term and common ratio of geometric sequences
		13.3.2. Formulas for general term of geometric sequences
		13.3.3. Definition of geometric mean
		13.3.4. Summation of the geometric series
		13.3.5. Definition of infinite series
		13.3.6. Formula for summation of infinite series
	13.4. Annuity and Compound Interest	13.4.1. Meaning of compound interest and annuity
		13.4.2. Problems solving of compound interest and annuity
	13.5. Summation of Special Series	13.5.1. Summation of Special Series
14. Determinants	14.1. Determinants	14.1.1. Definition of first order, second order and third order of

		determinants
		14.1.2. Expansion of third order determinants
		14.1.3. Nature and value of determinants
		14.1.4. Finding determinants value by using cofactor expansion
	14.2. Nature of Determinants	14.2.1. Nature of determinants
	14.3. Cramer's rule	14.3.1. Cramer's rule
15. Matrices	15.1. Matrices	15.1.1. Definition of matrix, equal matrix, zero matrix, identity matrix, and transpose matrix
	15.2. Arithmetic of Matrices	15.2.1. Addition and subtraction of matrices
		15.2.2. Scalar product of matrices
		15.2.3. Multiplication of matrices
	15.3. Inverse Matrices and their Application	15.3.1. Definition of inverse matrices
		15.3.2. Inverse of second order square matrices and third order square matrices
	15.4. Linear Simultaneous Equations	15.4.1. Linear simultaneous equations (inverse matrices, Gaussian elimination)
16. Circles	16.1. Formula of a Circle	16.1.1. Definition of locus
		16.1.2. Finding standard form and general form of the circle from given conditions
		16.1.3. Finding centre of circle and radius from given formula of circle or other conditions
		16.1.4. The relationship between point and circle, shortest and longest distance between a point and a circle
	16.2. The Relationship Between Line and Circle	16.2.1. The positional relationship between line and circle
		16.2.2. Definition of tangent
	16.3. The Relationship of Distances Between the Centres of Two Circles	16.3.1. Definition of circumscribe, inscribe, intercept, and separate of circles
		16.3.2. The positional relationship of distances between two circles
17. Plane Vectors	17.1. Vectors	17.1.1. Definition of vector, zero vector, equal vector and inverse vector
		17.1.2. Vectors and scalars

		17.1.3 Summation of vectors, triangle law of vector addition and parallelogram law of vector addition
		17.1.4. Multiplication of vectors
	17.2. Components of a Vector	17.2.1. Definition of position vector and unit vector
		17.2.2. Magnitude of a vector
		17.2.3. Representation of position vector in coordinates system
		17.2.4. Coordinates form or unit vector to represent addition or subtraction of vectors
	17.3. Vector in Geometric Plane	17.3.1. Meaning of Midpoint Theorem, Proportionality Theorem
		17.3.2. Problems solving of vectors
18. Solid Geometry	18.1. Angle between line and plane	18.1.1. The position of the angle formed by a line and a plane
		18.1.2. The angle formed by a line and a plane
	18.2. Dihedral Angles	18.2.1. The position of the dihedral angle
		18.2.2. Dihedral angles
	18.3. Applications of Simple Geometric Solids	18.3.1. Problems solving of simple geometric solids
19. Permutation and Combination	19.1. Principle of Addition and Principle of Multiplication	19.1.1. Meaning of Principle of Addition and Principle of Multiplication
	19.2. Permutation of Distinct Elements	19.2.1. Formula of permutation and problems solving of permutation about linear permutation
		19.2.2. Repetition permutation of distinct elements
	19.3. Circular Permutation of Distinct Elements	19.3.1. Meaning of circular permutation
		19.3.2. Problem solvings of circular permutation (exclude non-distinct elements)
	19.4. Permutation of Non-Distinct Elements	19.4.1. Problem solvings of permutation about non-distinct elements
	19.5. Combination	19.5.1. Formula of combination
		19.5.2. Problems solving of combination
	19.6. Permutation and Combination	19.6.1. Problems solving of permutation and combination

20. Binomial Theorem	20.1. Binomial Theorem with Natural Number Power	20.1.1. Binomial Theorem with natural number power
	20.2. Binomial Theorem with Rational Number Power	20.2.1. Binomial Theorem with rational number power
		20.2.2. Binomial with rational number power and Its Limit
21. Limits	21.1. Limit of Series	21.1.1. Meaning of limit of series and its calculation
	21.2. Limit of Functions	21.2.1. Meaning of left limit, right limit and limit of function
		21.2.2. Existence of function limit, right limit of function and left limit of function
	21.3. Nature of Function Limit	21.3.1. Nature of function limit
	21.4. Continuity of a Function	21.4.1. Definition and condition of continuity of a function
		21.4.2. Continuity of a function
22. Differentiation and its Application (I)	22.1. Derivatives	22.1.1. Meaning of derivatives, using definition of derivative to find derivatives
		22.1.2. Relationship between differentiability and continuity
	22.2. Differentiation Rules	22.2.1. Differentiation rules of addition, subtraction, multiplication and division of functions
		22.2.2. Derivative of power functions
	22.3. Chain Rule	22.3.1. Finding derivative of composite functions by the chain rule
	22.4. Higher Degree Derivative	22.4.1. Higher degree derivative
	22.5. Tangents and Normals	22.5.1. Tangent and normal to a curve at a point
	22.6. Increasing or Decreasing Functions	22.6.1. Meaning of monotonic
		22.6.2. Increasing or decreasing functions
	22.7. Extrema	22.7.1. Global maximum value, global minimum value, local maximum value and local minimum value of functions
		22.7.2. Finding stationary points, application of first derivative test or

		second derivative test to determine extrema values
		22.7.3. Problems solving of extrema
	22.8. Variabilities and Correlated Variabilities	22.8.1.Meaning of variabilities and correlated variabilities
		22.8.2. Problems solving of variabilities and correlated variabilities
23. Indefinite Integrals (I)	23.1. Indefinite Integrals	23.1.1. Relationship between indefinite integrals and differentiation
	23.2. Basic Arithmetic and Formula of Indefinite Integrals	23.2.1. Integral formulas, constant rule and formula for integral by parts
	23.3. Integration by Substitution	23.3.1. Integration by substitution
24. Definite Integral	24.1. Concepts of Definite Integral	24.1.1. Meaning of definite integral
		24.1.2. Relationship between definite integral and indefinite integral, meaning of Fundamental Theorem of Calculus
		24.1.3. Finding area of the trapezoids with curve, relationship between definite integral and Riemann Sum
	24.2. Arithmetic of Definite Integral	24.2.1. Calculation of definite integral
	24.3. Arithmetic of Area	24.3.1. The area between curves
	24.4. Volume of a Rotating Solid	24.4.1. Volume of a rotating solid revolved through 360° about the axis
	24.5. Linear Motion Problems	24.5.1. Relationship between instantaneous velocity, instantaneous acceleration and derivative
		24.5.2. Instantaneous velocity, instantaneous acceleration and derivative in linear motion
		24.5.3. Problems solving of linear motion
25. Statistics	25.1. Basic Concepts of Statistics and Data Analysis	25.1.1. Meaning of box plot
		25.1.2. Effects of statistical data outliers
	25.2. Central Tendencies	25.2.1. Central tendency and weighted mean
		25.2.2. Advantages and disadvantages of central tendencies, influences of data conversion on central

		tendencies and meaning of central tendencies
	25.3.Dispersion Tendencies	25.3.1. Dispersion tendencies (standard deviation, variance)
		25.3.2. Advantages and disadvantages of dispersion tendencies, influences of data conversion on central tndencies and meaning of dspersion tendencies
		25.3.3. Coefficient of variation
	25.4. Statistical Indices	25.4.1. Meaning of statistical indices and composite indices
		25.4.2. Calculation of statistical indices and composite indices
26. Probabilities	26.1. Principle of Addition	26.1.1. Meaning of sample space, events and probability
		26.1.2. Probabilities of mutually exclusive events and complementary events, and their calculations
	26.2. Principle of Multiplication	26.2.1. Meaning of independent events and its probability calculation
		26.2.2. Meaning of dependent events and its probability calculations.
		26.2.3. Bayes' Theorem
	26.3. Expectations	26.3.1. Meaning of expected value and its Calculation
	26.4. Binomial Distribution	26.4.1. Meaning of binomial distribution and its calculation
	26.5. Normal Distribution	26.5.1. Meaning of normal distribution and its application
27.Linear Regressions	27.1.Correlation Coefficients	27.1.1. Two dimensional scatter plot
		27.1.2. Definition and finding of correlation coefficients
		27.1.3. Definition of correlation
	27.2. Simple Linear Regression Models	27.2.1. Definition of independent variable and dependent variable
		27.2.2. Using simple least squares regression to built model
28. Differentiation and its Application (II)	28.1. Differentiation of Implicit Functions	28.1.1. Differentiation of implicit functions
	28.2. Derivatives of Trigonometric Functions	28.2.1. $\lim_{x\to 0}\frac{\sin x}{x}$
		28.2.2. Derivatives of trigonometric

		functions
	28.3. Derivatives of Logarithmic Functions and Exponential Functions	28.3.1. The value of $\lim_{x\to 0}(1+x)^{\frac{1}{x}}$
		28.3.2. Derivatives of logarithmic functions and exponential functions
	28.4. Logarithmic Differentiations	28.4.1. Logarithmic differentiations
	28.5. L'Hôpital's Rule	28.5.1. L'Hôpital's Rule ($\frac{0}{0}$ indeterminate form and $\frac{\infty}{\infty}$ indeterminate form)
	28.6. Convexity , Inflection Point and Asymptote of the Curves	28.6.1. Convexity, inflection point and asymptote of the curves
		28.6.2. Sketching curves
29. Definite and Indefinite Integral (II)	29.1. Using Antiderivative to Find Integration	29.1.1. Using antiderivative to find integration
	29.2. Integration by Partial Fraction	29.2.1. Meaning and arithmetic of integration by partial fraction
		29.2.2. Finding integral by using partial fraction
	29.3. Integration of Trigonometric Functions	29.3.1. Integration of sine function and cosine function
		29.3.2. Integration of sine function and cosine function with odd power and even power
	29.4. Trigonometrical Substitution	29.4.1. Finding $\sqrt{a^2-x^2}$, $\sqrt{a^2+x^2}$, $\sqrt{x^2-a^2}$ by using trigonometrical substitution
	29.5 Integration by parts	29.1.1. Integration by parts
30. Differential Equations	30.1. First Order Differential Equations	30.1.1. Properties of first order differential equations
		30.1.2. Identifying differential equations
	30.2. Separable Differential	30.2.1. Variable separable differential equations and their solution

	Equations	
	30.3. First Order Linear Differential Equations	30.3.1. Solving first order differential equations by using integrating factors
	30.4. Application of First Order Linear Differential Equations	30.4.1. Problems solving of first order linear differential equations
31. Mathematical Methods	31.1. Mathematical Induction	31.1.1. Meaning of mathematical induction and its proof
	31.2. Proof of Inequality	31.2.1. Meaning and application of comparative method
		31.2.2. Meaning of inequality of arithmetic and geometric means and their applications
	31.3. Proof by Contradiction	31.3.1. Counterexample proof by contradiction
	31.4. Numerical Methods	31.4.1. First order approximation of a function
		31.4.2. Meaning of newton's method and application in finding approximation of root
		31.4.3. Meaning of trapezoidal method and application in finding approximation of area
32. Transformation of Axes	32.1. Transformation of Axes	32.2.1. Meaning of translation and rotation of the axis
		32.2.2. Formulas for translation and rotation of the axis
33. Conic Sections	33.1. Parametric Equations	33.1.1. Polar coordinates
		33.1.2. Meaning of polar coordinates
	33.2. Conic Sections	33.2.1. Parabolas, ellipses, hyperbolas
		33.2.2. Definition and finding of focus, directrix and eccentricity
	33.3. Parabolas	33.3.1. Standard equation of parabolas
		33.3.2. Geometric properties of parabolas
	33.4. Ellipses	33.4.1. Standard equation of ellipses
		33.4.2. Geometric properties of ellipses
	33.5. Hyperbolas	33.5.1. Standard equation of hyperbolas
		33.5.2. Geometric properties of hyperbolas
34. Complex Numbers	34.1. Complex Numbers	34.1.1. Meaning of expansion of number, imaginary number, complex number and complex conjugate

		34.1.2. Addition and subtraction, multiplication and power, and division of complex numbers
	34.2. Arguments and Modulus of Complex Number in Complex Plane	34.2.1. Relationship between complex numbers and cartesian cordinate system, meaning of complex plane
		34.2.2. Representing complex numbers in vector form
		34.2.3. Representing complex numbers in complex plane
		34.2.4. Meaning and value of modulus of complex number and argument
	34.3. Complex Numbers in Trigonometric Functions	34.3.1. Meaning of trigonometric function
		34.3.2. Multiplication and division of complex numbers in trigonometric functions
		34.3.3. Algebraic expression for complex numbers and conversion of trigonometric functions
	34.4. De Moivre's Theorem	34.4.1. Meaning of De Moivre's Theorem
		34.4.2. Problem solvings of De Moivre's Theorem
	34.5. Nature of Root	34.5.1. Fundamental Theorem of Algebra
		34.5.2. Conjugate root
35. Vector Space	35.1. Space Rectangular Coordinate System	35.1.1. Coordinates and axes in space
		35.1.2. Distance between two points in space
	35.2. Geometry of Vector Space	35.2.1. Addition and subtraction of vector space and scalar product in vector space
		35.2.2. Magnitude of a vector
		35.2.3. Finding midpoints in space by using Midpoint Theorem
	35.3. Inner Products of Vectors	35.3.1. Meaning and nature of inner product
		35.3.2. Inner product
		35.3.3. Meaning and finding angle between two vectors
		35.3.4. The vector projection of one vector over another vector
	35.4. Outer Products of Vectors	35.4.1. Meaning and nature of outer product
		35.4.2. Calculation, size and direction of outer products
	35.5. Equations of	35.5.1. Equations of plane in space

	Lines and Planes in Space	35.5.2. Equations of line in space

7.2 Learning Standards

Students acquire subject knowledge, competencies, attitude, and core values from cognitive, psychomotor, and affective (as indicated in table 5) in learning standards of Advanced Mathematics. The connotations of these domains are further explained in table 6. Table 7-1 and 7-2 are correspondence table mapping examples of content standards and learning standards for reference in lesson plans.

Table 5

Learning Standards

Domain	Cognitive (C)	Psychomotor (P)	Affective (A)
Item	Ca Mathematic Facts Cb Mathematic Concepts Cc Mathematic Procedures	Pa Mathematizing Pb Analysing Pc Problem-solving Pd Communicating Pe Applying Tools	Aa Learning Confidence Ab Motive Ac Mathematical Disposition

Table 6

Description of Items in Learning Standards

Domain	Item	Descriptions
Cognitive (C)	Ca Mathematical Element	I. Indicates elementary elements of mathematics, e.g., symbols, graphics and definitions. Students understand and master elements of mathematics and representations.
	Cb Mathematical Knowledge	I. Indicates relationships between mathematical elements. Students understand mathematical concepts, theorems, and laws.
	Cc Mathematical Procedure	I. Indicates formation procedures and steps of mathematical elements and knowledge
Psychomotor (P)	Pa Mathematize	I. Indicates arithmetic, algorithm, modelling and visualising.
	Pb Analysing	I. Indicates analysing problems and making reasonable inferences.
	Pc Problem-solving	I. Indicates applying suitable strategies and solving problems effectively.
	Pd Communicating	I. Indicates grasping the meaning of information and conveying it to others effectively.
	Pe Applying Tools	I. Indicates applying tools (e.g., geometric

		instrument, calculator, and computer) to solve problems.
Affective (A)	Aa Learning Confidence	I. Indicates self-confidence in learning mathematics.
	Ab Motive	I. Indicates putting in effort spontaneously and maintaining initiative in learning mathematics.
	Ac Mathmatical Disposition	I. Indicates the ability to think independently, understand the nature and value of mathematics, and apply to one's life.

Table 7-1

First Example of Alighment of Content Standards and Learning Standards

Learning Standards / **Content Standards**	**Cognitive** **CcI** Indicates formation procedures and steps of mathematical elements and knowledge	**Psychomotor** **PaI** Indicates ability of arithmetic, algorithm, modelling and graphic.	**Affective** **AaI** Indicates building self-confidence in students of mathematics.
3.1.2 Arithmetic and Synthetic Division of Polynomials, Meaning of Factorization and Multiplication in Polynomials	Understand the concept and relationship of factors and multiples.	Able to operate the arithmetic of polynomials.	Perform the procedure with confidence and patience.

Table 7-2

Second Example of Alignment of Content Standards and Learning Standards

Learning Standards / **Content Standards**	**Cognitive** **CcI** Indicates formation procedures and steps of mathematical elements and knowledge	**Psychomotor** **PaI** Indicates ability of arithmetic, algorithm, modelling and graphic.	**Affective** **AaI** Indicates building self-confidence in students of mathematics.
25.2.2 Advantages and Disadvantages of Central Tendencies, Influences of Data Conversion on Central Tendencies and Meaning of Central Tendencies	Understand the meaning of central tendencies	Able to make reasonable inferences on meaning of central tendencies.	Curious in various interpretation of central tendencies.

8. Pedagogical Suggestions

Recommendations for Advanced Mathematics teaching period allocation are: Senior Middle One and Senior Middle Two 7 periods every week, while Senior Middle Three 5 periods every week. Each period lasts for 40 minutes. The course comprises 35 chapters, the period allocation for each chapter is indicated in table 8. In addition, each chapter can be allocated a flexible 1-5 period for previewing, revision, and implementation of mathematical activities to ensure diverse learning in this course. Teachers may adjust these periods according to the level of learning and progress of teaching.

Table 8

Periods Allocation Recommendation for Advanced Mathematics

Level	Chapter	Chapter Name	Period Allocation Recommendation
Senior Middle One A	1	The Cartesian Coordinate System and Linear Equations	10 - 12
	2	Quadratic Equations	7 - 8
	3	Polynomials	14
	4	Irrational Expression	7
	5	Function	14 - 16
	6	Inequality	16 - 18
	7	Logic	5 - 7
Senior Middle One B	8	Angles and Radians	6
	9	Trigonometric Functions of Arbitrary Angles	14
	10	Applications of Trigonometry	10
	11	Trigonometric Identities and Trigonometric Equations	18 - 20
	12	Indices and Logarithms	10 - 12
	13	Sequence and Series	20
		Total	151-164
After increasing 1-5 flexible periods in 13 chapters			164-229
Senior Middle Two A	14	Determinants	6 - 7
	15	Matrices	6 - 7
	16	Circles	16 - 18
	17	Plane Vectors	10 - 12
	18	Solid Geometry	7 - 8
	19	Permutations and Combinations	14
	20	Binomial Theorem	5
Senior Middle Two B	21	Limits	7
	22	Differentiation and Its Applications (I)	25
	23	Infinite Integrals (I)	8 - 10
	24	Definite Integrals and Its Applications	14
	25	Statistics	14
	26	Probabilities	14

	27	Linear Regression	6 - 8
		Total	152-163
After increasing 1-5 flexible periods in 14 chapters			166-233
Senior Middle Three A	28	Differentiation and Its Applications	12 - 14
	29	Definite and Indefinite Integrals(II)	12 - 14
	30	Differential Equations	10 - 12
	31	Mathematical Methods	18 - 20
Senior Middle Three B	32	Transformaiton of Axes	5 – 7
	33	Conic Sections	15 - 20
	34	Complex Numbers	15 - 20
	35	Vector Space	15 - 20
		Total	102 – 127
After increasing 1-5 flexible periods in 8 chapters			110-167
Total of three senior level			**440-629**

"The *Main Standards*" suggests that teachers should cultivate and promote four competencies, as shown (Figure 4). First, technical knowledge is required to increase, e.g., how to apply internet resources, how to operate mathematical software and new platform and how to make learning worksheets.

Second, teaching methods. Orthodox teaching is not "one-size-fits-all", instead "student-centered learning" is more recognized nowadays. The *Main Standards* emphasizes the competency of exploring knowledge on oneself, thus teachers should adjust learning roadmap, so that students are given more opportunity to explore and apply the knowledge to solve problems.

Third, curriculum concepts. "The *Main Standards*" emphasizes the balanced implementation of "imparting knowledge" and "nurturing students". Thus, teachers should have a grasp of the holistic cultivation concept of the newly implemented "The *Main Standards*", meanwhile have a grasp of core competencies connotations too. Teachers are not merely practitioners of teaching materials, but also creators of teaching activities and programs by fusing the content of teaching materials and competencies.

Lastly, subject knowledge. Teachers need to have a comprehensive understanding of subject matter knowledge. She/ He must clearly understand the subject's purpose, connections across subjects and the world, connection between learning point and holistic knowledge of subject.

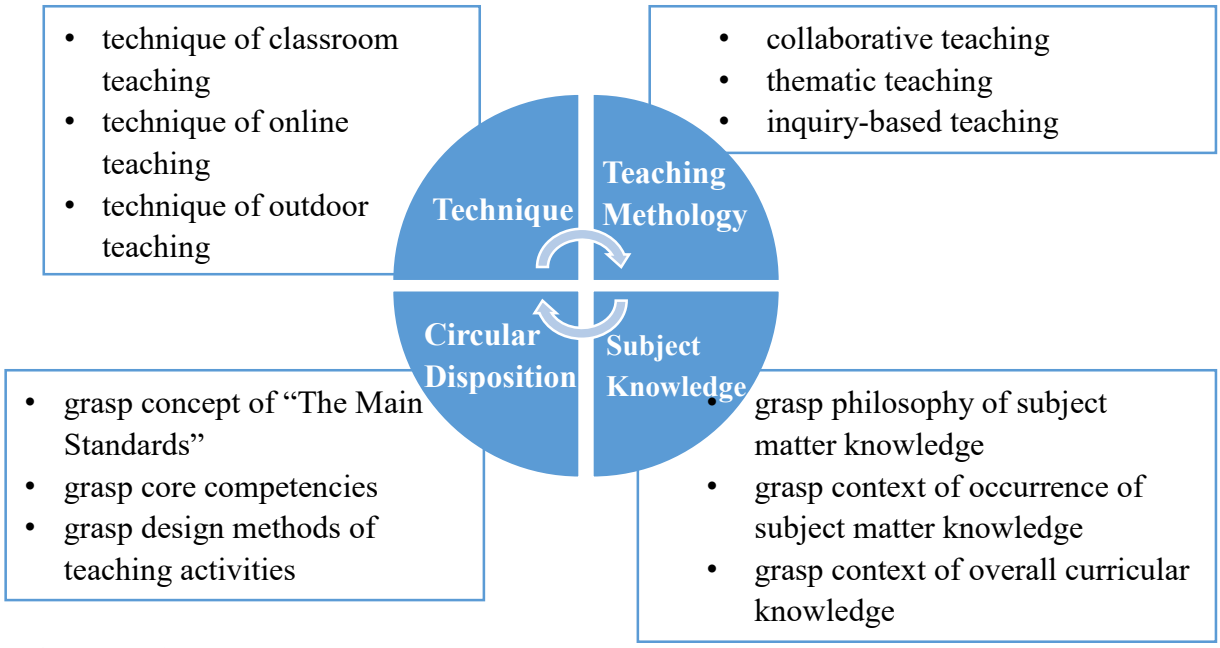


Figure 4: Four Competencies in Which Teachers Should Cultivate in Accordance to "the *Main Standards*"

9. Assessment Suggestions

9.1. Assessment is an effective way to examine teaching efforts. Various assessment methods should be applied to examine the learning progress and outcomes of students. Assessment methods include written tests, oral tests, assignments, thematic studies, group presentations, school exams, etc. Modes of assessment should be implemented after the observation of the on-scene requirements of the lesson.

9.2. Teachers should take learning achievement, progress, readiness, and motive of different students into account and analyze whether students have met curriculum requirements before giving assessments. In assessments, complex or demanding questions are inadvisable.

9.3. Appropriate timing is also important when assessments are implemented to avoid students' burdens or inaccurate interpretation of results. For instance, oral responses and homework can be used as reference for teaching plans; classroom tests can be a mean to detect and rectify students' problems timely; thematic studies, group presentation or school exams are valuable feedbacks for measuring and mentoring students' learning progress.

9.4. Assessment aims reflect students' learning progress; thus adequate time and space are compulsory during the assessment. Setting multiple-choice questions should avoid the chances of guesstimates for candidates. Subjective questions should request candidates to write down necessary steps and solutions to examine students' thinking ideas. The scheme must be set for marking subjective questions, while marks should be distributed accordingly to steps. Meanwhile, try to guide students to understand their mistakes and rectify them if possible.

9.5. UEC (Unified Examination Certificate) can be the final evaluation of students learning outcomes. In addition, the results can be reference for their future planning.

9.6. To consider various learning methods, diversified assessments should be implemented. In this way, the assessments are beneficial to student's all-around development. The table below (table 9) indicates the performance standards of cognitive, affective, and psychomotor, expressed at different levels accordingly. Table 10 indicates an example of comprehensive application of content, learning, and performance standards as a reference for writing lesson plans. Besides that, the attached appendix 2 is applicable as a template for performance standards in lesson plans.

Table 9

Performance Standards

Domain	Item	Level	Performance Standards
Cognitive (C)	Ca Mathematical Element	1 Remember	List and mark out mathematics elements.
		2 Understand	Interpret meaning of mathematics elements.
		3 Apply	Apply mathematics elements.
		4 Analyse	Choose suitable mathematics elements under different circumstances.
		5 Evaluate	Determine the application of mathematics elements and its reasonableness.
		6 Create	Reorganize mathematics elements to form new mathematical modal or structure.
	Cb Mathematical Knowledge	1 Remember	Describe mathematical concept, theorem and principle.
		2 Understand	Interpret mathematical concept, theorem and principle.
		3 Apply	Apply mathematical concept, theorem and principle.
		4 Analyse	Choose suitable mathematical concept, theorem and principle under different circumstances.

		5 Evaluate	Determine the suitability of mathematical concept, theorem and principle.
		6 Create	Generate activity related to mathematical concept, theorem and principle.
	Cc Mathematical Procedure	1 Remember	Write the steps.
		2 Understand	Understand the sequence and relationships of the steps.
		3 Apply	Apply the steps independently.
		4 Analyse	Reorganize, ensure the relationship between steps.
		5 Evaluate	Determintae the reasonableness of steps.
		6 Create	Generate activity related to mathematical procedure.
Psychomotor(P)	Pa Mathematize	1 Imitation	Imitate others' action.
		2 Manipulation	Complete mathematical task independently.
		3 Precision	Complete mathematical task accurately.
		4 Articulation	Complete complicated mathematical task accurately.
		5 Naturalisation	Complete different complicated mathematical task independently, accurately and skillfully.
	Pb Analysing	1 Imitation	Imitate others' action.
		2 Manipulation	Understand the main idea of the question, graphics and make preliminary inference independently.
		3 Precision	Grasp the context of the question, interpret the graphics and make reasonable inference.
		4 Articulation	Analyze different question, interpret various information by interlinking new and old knowledge,

			and make reasonable inference.
		5 Naturalisation	Analyze different questions, make reasonable inference and exclude unconvincing evidence.
	Pc Problem Solving	1 Imitation	Imitate others' actions.
		2 Manipulation	Choose resolution strategy independently.
		3 Precision	Choose good strategy to solve problem effectively.
		4 Articulation	Choose suitable strategies in the light of different tasks independently and solve the problems effectively.
		5 Naturalisation	Choose suitable strategies in the light of different tasks independently and solve the problems effectively and skillfully.
	Pd Communicating	1 Imitation	Imitate others' actions.
		2 Manipulation	Apply mathematical diagrams, graphics, etc.
		3 Precision	Apply mathematical diagrams, graphics, etc. to express opinions.
		4 Articulation	Apply mathematical diagrams, graphics, etc. in the light of different tasks, and explain their connotation.
		5 Naturalization	Apply mathematical diagrams, graphics, etc. in the light of different tasks, and explain their connotation independently, effectively and skillfully.
	Pe Applying Tools	1 Imitation	Imitate others ways of using mathematical tool.
		2 Manipulation	Use mathematical tools independently.

		3 Precision	Use suitable mathematical tools to complete sophisticated tasks.
		4 Articulation	Use mathematical tools to complete different tasks in flexibility.
		5 Naturalization	Use mathematical tools to complete different tasks in accurate and skillful way.
Affective (A)	Aa Learning Confidence	1 Receiving	Imitate others' actions.
		2 Responding	Apply mathematical diagrams, graphics, etc.
		3 Valuing	Apply mathematical diagrams, graphics, etc. to express opinions.
		4 Organising & Conceptualising	Apply mathematical diagrams, graphics, etc. in the light of different tasks, and explain their connotation.
		5 Characterising by Values	Apply mathematical diagrams, graphics, etc. in the light of different tasks, and explain their connotation independently, effectively and skillfully.
	Ab Motive	1 Receiving	Imitate others ways of using mathematical tool.
		2 Responding	Use mathematical tools independently.
		3 Valuing	Use suitable mathematical tools to complete sophisticated tasks.
		4 Organising & Conceptualising	Use mathematical tools to complete different tasks in flexibility.
		5 Characterising by Values	Use mathematical tools to complete different tasks in accurate and skillful way.
	Ac Mathematical Disposition	1 Receiving	Willing to learn mathematics.
		2 Responding	Show enthusiasm for learning mathematics.

		3 Valuing	Learn mathematics confidently, and recognize limitations in her/ his learning.
		4 Organising & Conceptualising	Keen on learning mathematics, achieve breakthroughs in limitation in learning.
		5 Characterising by Values	Keen on learning mathematics, and willing to share.

Table 10-1

First Example of Alignment of Content Standards and Learning Standards with Performance Standards

Learning Standards / **Content Standards**	**Cognitive**	**Psychomotor**	**Affective**
	CcI Indicates formation procedures and steps of elementary elements and knowledge	**PaI** Indicates ability of arithmetic, algorithm, modelling and graphic.	**AaI** Indicates building self-confidence in students of mathematics.
3.1.2 Arithmetic and Synthetic Division of Polynomials, Meaning of Factorization and Multiplication in Polynomials	Understand the concept and relationship of factors and multiples.	Able to operate the arithmetic of polynomials.	Perform the procedure with confidence and patience.
Performance Standards	Reorganize, ensure the relationship between steps. **(Ca4)**	Complete mathematical task accurately. **(Pa3)**	Keen on learning mathematics, achieve breakthroughs in limitation in learning.**(Aa4)**

Table 10-2

Second Example of Alignment of Content Standards and Learning Standards with Performance Standards

Learning Standards / **Content Standards**	**Cognitive**	**Psychomotor**	**Affective**
	CcI Indicates formation procedures and steps of elementary elements and knowledge	**PaI** Indicates ability of arithmetic, algorithm, modelling and graphic.	**AaI** Indicates building self-confidence in students of mathematics.
25.2.2 Advantages and Disadvantages of Central Tendencies, Influences of Data Conversion on Central Tendencies and Meaning of Central Tendencies	Understand meaning of central tendencies	Able to make reasonable inference on meaning of central tendencies.	Curious in various interpretation of central tendencies.
Performance Standards	Interpret mathematical concept, theorem and principle.**(Cb2)**	Analyze different question, interpret various information by interlinking new and old knowledge, and make reasonable inference. **(Pb4)**	Understand rigourous and systematic characteristics of mathematics, learn to self-reflect and see issues from different perspectives.**(Ac3)**

10. Implementation Highlights

10.1. Principles in compiling teaching material

a. Compilation of teaching material should align closely with basic concepts, core competencies, curricular objectives, and curricular structure of Advanced Mathematics.

b. Teaching materials include textbooks and teacher manuals. The purpose of the compilation of teaching material is to provide a strong framework to understand the textbook and curriculum, and support teachers in promoting quality education while taking care of students of varying demands.

c. Learning content must follow the principle of arrangement in which explicit mathematical concepts are shown without overwhelming extra concepts.

d. The compilation of teaching material should emphasize the overall structure and interlinkage between mathematical concepts. The interdisciplinary approach or integration of daily life material in implementatimg teaching material are also encouraged.

e. Teaching material compiled should be demonstrated gradually with appropriate elaboration, various mathematical representations, which stimulate learning interest and strike a balance between intuitive and rigour.

f. The textbook should provide abundant exercises or tasks to reflect the thinking of students. Teachers can grasp student's learning situation in time via these exercises or tasks, so they can adjust accordingly. These exercises or tasks should focus on the learning theme, and from easy to difficult, excluding meaningless tough and tricky questions.

g. History and culture of mathematics, mathematicians can be introduced in the textbook to stimulate students' interest in mathematics, foster an aesthetic appreciation for mathematics, and understand the contribution of mathematics to humankind.

10.2. Recommendations on School Equipment

a. Basic teaching aids: large ruler and compass, sphere modal, geometric frame, transparent three-dimensional modal, three view drawing, etc.
b. Basic classroom equipment: black board or white board, computer, projector, screen, sound system, etc.
c. Multimedia room: enough time to travel back and forth between the classroom and the multimedia room.
d. Mathematical software: geogebra (mobile version, PC version), Desmos, etc.
e. Q&A: Kahoot (buzzer quiz), Google Form (questionnaire), Slido (anonymous questioning), etc.
f. Before using the equipments, take note that the following points and make timely adjustment if needed:
    i. Is the room well-lit? Is there any reflection of light?
    ii. Is the size of the screen suitable for students' eyesight? Do students sitting at the back of the classroom or corner far away from the screen see it clearly?
    iii. Is the audio system's volume disrupting neighbouring classes? Or is the volume too low?
    iv. Is air ventilation proper when the windows and doors are shut?

10.3 Resources

a. Appropriate use of teaching aids during a lesson in order to foster cognitive visualization and thinking for better teaching effects.

b. Self-made teaching aids or take materials from readily available ones (e.g., rope, rubber band, bottle cap, pencil case, pen) are prioritized, whilst complicated teaching aids (e.g., large ruler and compass, sphere modal, geometric frame) should be provided by school.

c. Teachers may integrate electrical equipments (e.g., computer, projector) with mathematics teaching, such as three-view drawings, changes in statistical chart, transformation of a function graph, calculating the volume of solid of revolution by integration, etc.

d. Teachers may integrate available online resources (e.g., educational YouTube channels, Dong Zong E-Learning, Facebook MICSS mathematics forum, and mathematics anecdotes

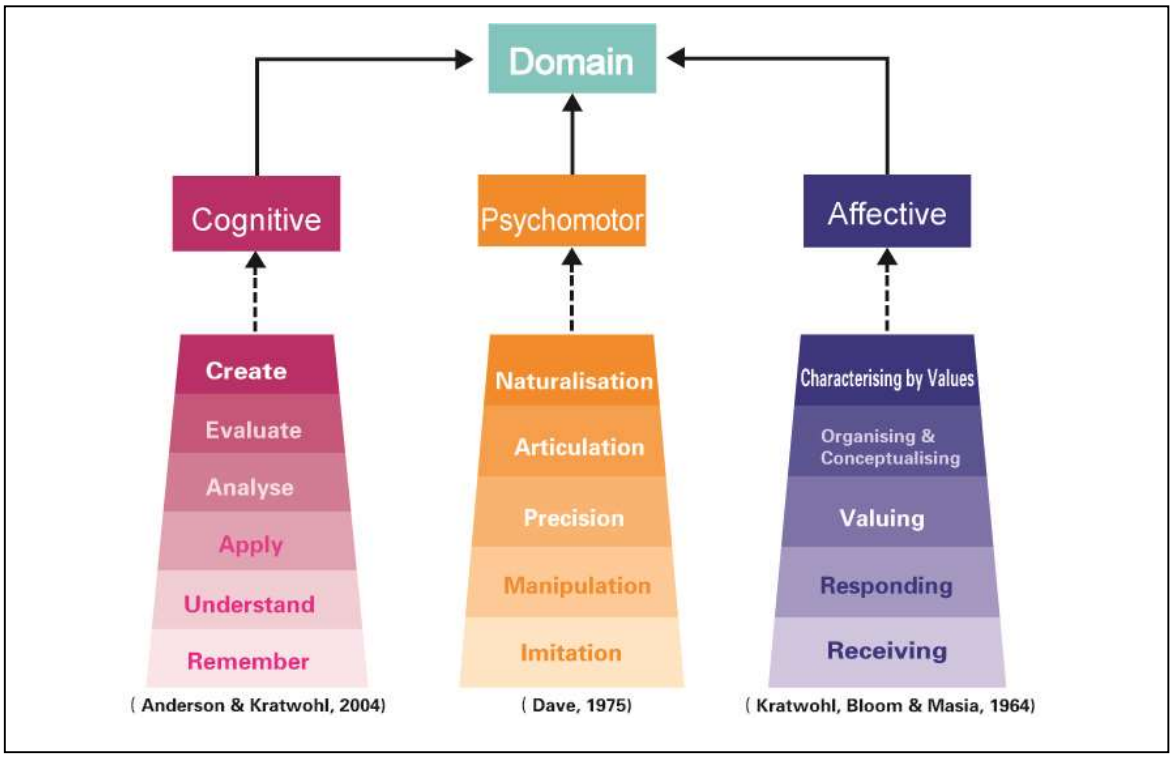
from all over the world) to create meaningful teaching. However, classroom teaching cannot be replaced by these resources.

e. A calculator is one of the essential tools for senior level students. Teachers should cultivate a positive attitude towards scientific calculator use in mathematics instruction while enabling them to understand calculators and computerized calculations are not everything. Apart from numerical errors, there is the possibility of input errors, procedural errors and insufficient significant figures, etc. It puts the students in a position whereby calculators are used to performing complicated arithmetic operations or checking algorithms, perceiving the reasonableness of the calculation outcomes and strengthening students' number sense.

11. Appendices

Appendix 1

Cognitive, Affective and Psychomotor Domains



Appendix 2

Template of Perfomance Standards

Chapter :			
Content Standards	**Learning Standards**		**Performance Standards**
	Cognitive (C)	Ca Mathematical Element	1 2 3 4 5 6
		Cb Mathematical Knowledge	1 2 3 4 5 6
		Cc Mathematical Procedure	1 2 3 4 5 6
	Psychomotor (P)	Pa Mathematize	1 2 3 4 5
		Pb Analysing	1 2 3 4 5
		Pc Problem Solving	1 2 3 4 5
		Pd Communicating	1 2 3 4 5
		Pe Applying Tools	1 2 3 4 5
	Affective (A)	Aa Learning Confidence	1 2 3 4 5
		Ab Motive	1 2 3 4 5
		Ac Mathematical Disposition	1 2 3 4 5