

Malaysian Independent Chinese Secondary Schools

**Senior Middle Level  
Mathematics Curriculum Standards**

Unified Curriculum Committee of  
Malaysian Independent Chinese Secondary School  
Working Committee  
2025

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# 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 to 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 for each subject are designed to align with the principles and direction set forth in the *Main Standards*, providing guidance on fundamental principles, objectives, competencies, curriculum concept and contents of the subjects, as well as pedagogical and assessment suggestions. 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.<sup>1</sup>

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<sup>1</sup> 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 broaden their global perspectives; and
- f. To create opportunities for students to partake proactively in various ethnic group activities, and ensure that they are able to interact and learn in cross-cultural environments.

## 3. Core Competencies

The *Main Curriculum Standards* are based on the six core competencies<sup>2</sup> 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 the Junior Middle Level and Senior Middle Level curriculum development. Core competencies emphasise the holistic qualities of individuals and encompass knowledge, skills and attitudes.

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<sup>2</sup> 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 major principles 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 framework is presented in a colour spectrum, revealing the integration of nine competencies with the three major principles. The misalignment of the inner and outer circles further clarifies that the implementation of each competency incorporates the three major principles. Based on the principle of integration and feasibility, the *Main Curriculum Standards* promote each principle through three competencies. Table 1 presents the core competencies and their definitions.

**Table 1***Junior and Senior Middle Level Core Competencies and Student Profiles*

| <b>Major Principles</b>             | <b>Core Competencies</b>                                          | <b>Definitions</b>                                                                                                                                                                                                                                                                                                                                                                                   | <b>Junior Middle Level</b>                                                                                                                                                                                                           | <b>Senior Middle Level</b>                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Student Profiles</b>                    |
|-------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| <b>A<br/>Self-Directed Learning</b> | <b>A1<br/>Physical-Mental Wellbeing and Aesthetic Development</b> | 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. | <b>One who cares about herself/himself</b> |
|                                     | <b>A2<br/>Knowledge and Technology Applications</b>               | 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          | 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.                                                                                                                                                                  | <b>One who is knowledgeable</b>            |

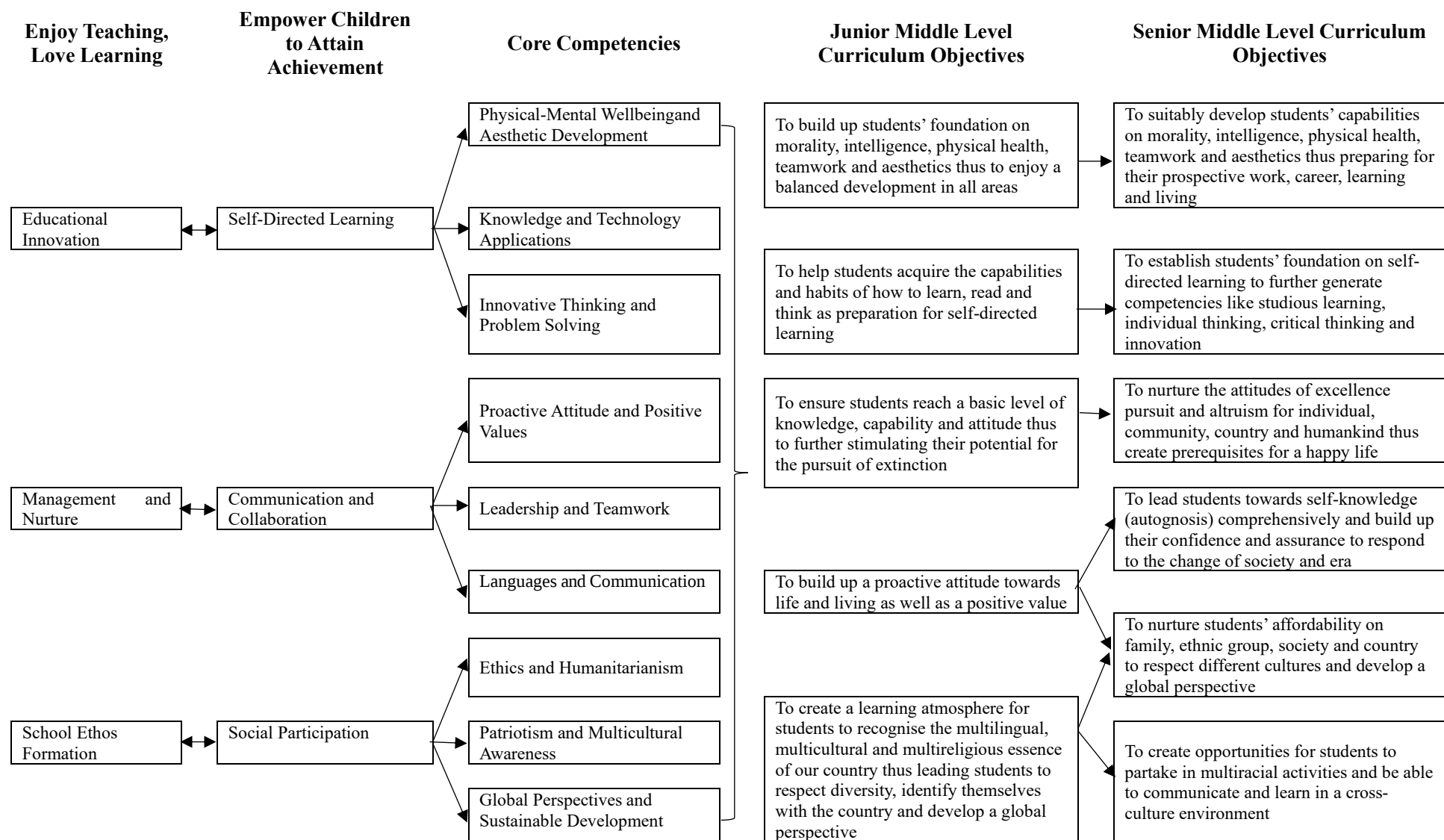
| Major Principles                         | Core Competencies                                 | Definitions                                                                                                                                                                                                                                                                                                                                                                                                  | Junior Middle Level                                                                                                                                                                                                                        | Senior Middle Level                                                                                                                                                                                                                                                                                                                                             | Student Profiles                                |
|------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
|                                          |                                                   | resolving difficulties in learning.                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                 |                                                 |
|                                          | <b>A3 Innovative Thinking and Problem Solving</b> | 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.                                                   | <b>One who can solve problems</b>               |
| <b>B Communication and Collaboration</b> | <b>B1 Proactive Attitude and Positive Values</b>  | 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. | <b>One who cares about others</b>               |
|                                          | <b>B2 Leadership and Teamwork</b>                 | She/He possesses the capability to lead and can effectively work and build up an interactive relationships with others thus developing teamwork competencies of                                                                                                                                                                                                                                              | 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                                                                      | She/He possesses compassion, personal judgment, gregarious capability and attitude; meanwhile, she/he develops communicative co-operation and teamwork competency;                                                                                                                                                                                              | <b>One who knows the importance of teamwork</b> |

| Major Principles              | Core Competencies                     | Definitions                                                                                                                                                                                                                                                                                                                                                                       | Junior Middle Level                                                                                                                                                                                                                                                                                                                                                                    | Senior Middle Level                                                                                                                                                                                                                                                                                                                                         | Student Profiles                            |
|-------------------------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
|                               |                                       | communication, negotiation and service.                                                                                                                                                                                                                                                                                                                                           | through collaboration.                                                                                                                                                                                                                                                                                                                                                                 | she/he can get along well with others collaboratively, and is able to complete the assignment well with advanced planning.                                                                                                                                                                                                                                  |                                             |
|                               | <b>B3 Languages and Communication</b> | 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. | <b>One who is skillful in communication</b> |
| <b>C Social Participation</b> | <b>C1 Ethics and Humanitarianism</b>  | 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.                        | <b>One who is open-minded</b>               |

| Major Principles | Core Competencies                                             | Definitions                                                                                                                                                                                                                                                                                                                                                                                                                     | Junior Middle Level                                                                                                                                                                                                                                                          | Senior Middle Level                                                                                                                                                                                                                                                                                                                                                      | Student Profiles                                               |
|------------------|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
|                  | <b>C2<br/>Patriotism and Multicultural Awareness</b>          | 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.        | <b>A patriot and one who loves her/his community</b>           |
|                  | <b>C3<br/>Global Perspectives and Sustainable Development</b> | 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. | <b>One who knows the importance of sustainable development</b> |

**Figure 2**

*The Relation of Major Principles, Core Competencies and Curriculum Objectives*



## 4. Fundamental Principles

The mission and objective of “the Main Standards” 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 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

Senior Middle Level Mathematics programme 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 collaboration", and "social 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 having completed the Senior Middle Mathematics, students are able to: |                                                                                                                                                                                                                                       |
| A<br>Self-Directed<br>Learning | A1<br>Physical-Mental<br>Wellbeing and<br>Aesthetic<br>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<br>Knowledge and<br>Technology<br>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<br>Innovative Thinking<br>and Problem 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<br>Communication<br>and<br>Collaboration | B1<br>Proactive Attitude<br>and Positive Values             | 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<br>Leadership and<br>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<br>Languages and<br>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<br>Social<br>Participation               | C1<br>Ethics and<br>Humanitarianism                         | 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<br>Patriotism and<br>Multicultural<br>Awareness          | 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<br>Global Perspectives<br>and Sustainable<br>Development | CO9 | Understand the future of mathematical, scientific, and technological development; concern herself/himself with societal and sustainable environmental development issues.                                                                                             |

## 6. Curriculum Concept

### 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 Middle 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 Middle One mathematics focuses on geometry, algebra and subsequent advanced trigonometry; Senior Middle Two on advanced algebra, geometry, statistics and probability; Senior Middle Three entirely introduces calculus. Mathematics (S.L.) is taught in the arts stream, commerce stream, arts and commerce stream, and technical stream. Thus, apart from demonstrating mathematical logic, Mathematics (S.L.) is also partially based on applied mathematics.

### 6.2 Period allocation

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

**Table 3**

*Period Allocation in Senior Middle One to Senior Middle Three*

| Subject            | Type                            | Target                             | Senior middle one |                 | Senior middle two |                 | Senior middle three |                 | 3 years in senior secondary |                                      |
|--------------------|---------------------------------|------------------------------------|-------------------|-----------------|-------------------|-----------------|---------------------|-----------------|-----------------------------|--------------------------------------|
|                    |                                 |                                    | Credit            | Period per week | Credit            | Period per week | Credit              | Period per week | Total credit                | Total period per week                |
| Mathematics (S.L.) | Dong Zong Curriculum (Required) | Arts / commerce / technical stream | 10                | 5               | 10                | 5               | 10                  | 5               | 30                          | $3 \times 40 \times 5 = 600$ periods |

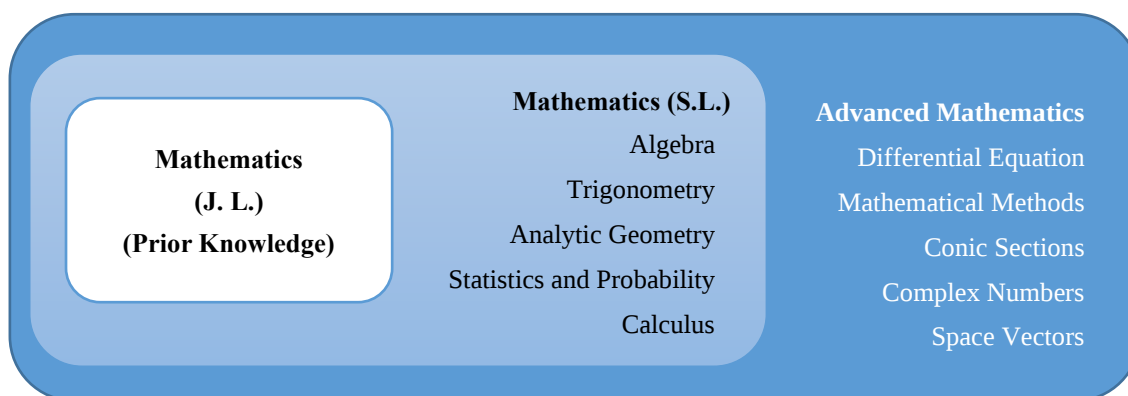
### 6.3 Subject Structure

Senior middle 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

**Table 4**

*Content Standards*

| Chapter                                           | Item                                                  | Details                                                                                      |
|---------------------------------------------------|-------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 1. Cartesian Coordinate System and Straight Lines | 1.1. Cartesian coordinate system and distance formula | 1.1.1. Cartesian coordinate system, quadrants, distance formula                              |
|                                                   | 1.2. Point dividing a line segment in a given ratio   | 1.2.1. Point dividing a line segment in a given ratio, section formula, midpoint formula     |
|                                                   | 1.3. Areas of polygons                                | 1.3.1. Area of triangle and its applications                                                 |
|                                                   |                                                       | 1.3.2. Area of polygon and its applications                                                  |
|                                                   | 1.4. Gradients of straight lines                      | 1.4.1. Gradient                                                                              |
|                                                   | 1.5. Equations of straight lines                      | 1.5.1. Equations of straight lines (point-slope form, gradient-intercept form, general form) |
|                                                   |                                                       | 1.5.2. Conditions of two parallel and perpendicular lines                                    |

|                                                                          |                                                                                                 |                                                                                                                                                                                                              |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                          | 1.6. Point of intersection of two straight lines                                                | 1.6.1. Relationship between the positions of two straight lines (parallel, perpendicular, coincident, intersecting)                                                                                          |
|                                                                          | 1.7. Distance from a point to a line                                                            | 1.7.1. Distance from a point to a line, distance between two parallel lines                                                                                                                                  |
| 2. Quadratic Equations in One Variable and Graphs of Quadratic Functions | 2.1. Discriminants of the roots of quadratic equations in one variable                          | 2.1.1. Definition of the discriminants of the roots of quadratic equations in one variable, determination of the natures of roots, determination of perfect squares                                          |
|                                                                          | 2.2. Relationship between the roots and coefficients of quadratic equations in one variable     | 2.2.1. Relationship between the roots and coefficients of quadratic equations in one variable                                                                                                                |
|                                                                          | 2.3. Graphs of quadratic functions and extrema                                                  | 2.3.1. Quadratic equations in one variable written in the form of $y = a(x - h)^2 + k$                                                                                                                       |
|                                                                          |                                                                                                 | 2.3.2. Graphs of quadratic functions, directions of openings, axes of symmetry, vertices, extrema, apply completing the square to find the extrema of quadratic functions                                    |
|                                                                          | 2.4. Relationship between the positions of the graphs of quadratic functions and straight lines | 2.4.1. Relationship between the positions of the graphs of quadratic functions and straight lines                                                                                                            |
| 3. Polynomials                                                           | 3.1. Polynomials                                                                                | 3.1.1. Degrees, coefficients, leading coefficients and constant terms of polynomials                                                                                                                         |
|                                                                          |                                                                                                 | 3.1.2. Four arithmetic operations of polynomials in one variable (addition and subtraction, multiplication and division), concepts of factors and multiples                                                  |
|                                                                          | 3.2. Remainder theorem                                                                          | 3.2.1. Remainder theorem and its applications                                                                                                                                                                |
|                                                                          | 3.3. Factor theorem                                                                             | 3.3.1. Factor theorem and its applications                                                                                                                                                                   |
|                                                                          | 3.4. Factorization of polynomials of one variable                                               | 3.4.1. Factorization of polynomials of one variable over rational numbers (taking out common factor method, cross multiplication method, formula method, grouping method, apply factor theorem to factorize) |
|                                                                          | 3.5. Solve higher degree equations in one variable                                              | 3.5.1. Solve general higher degree equations in one variable                                                                                                                                                 |
|                                                                          |                                                                                                 | 3.5.2. Solve specific higher degree equations in one variable by substitution                                                                                                                                |

|                           |                                                           |                                                                                                                                                                               |
|---------------------------|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4. Irrational Expressions | 4.1. Radical expressions, irrational expressions          | 4.1.1. Meaning of radical expressions and their basic properties                                                                                                              |
|                           |                                                           | 4.1.2. Simplifying radical expressions with different indices into radical expressions with equal indices                                                                     |
|                           | 4.2. Fractional exponents                                 | 4.2.1. Meaning of fractional exponents and their rules of operations                                                                                                          |
|                           |                                                           | 4.2.2. Movement of factors inside and outside of radical symbols                                                                                                              |
|                           |                                                           | 4.2.3. Simplifying radical expressions to the simplest form                                                                                                                   |
|                           | 4.3. Operations of radical expressions                    | 4.3.1. Like radical expressions, addition and subtraction, multiplication and division of radical expressions                                                                 |
|                           |                                                           | 4.3.2. Apply fractional exponents to perform multiplication and division of radical expressions                                                                               |
|                           | 4.4. Rationalizing factors and rationalizing denominators | 4.4.1. Rationalizing factors, rationalizing denominators in the form of $\sqrt{a} \pm \sqrt{b}$                                                                               |
| 5. Functions              | 5.1. Definition of function                               | 5.1.1. Definitions of correspondence and mapping, image and pre-image, determination of mapping                                                                               |
|                           |                                                           | 5.1.2. Definitions of function, independent variable and dependent variable                                                                                                   |
|                           |                                                           | 5.1.3. Representations of functions (analytical method, tabular method, graphical method)                                                                                     |
|                           | 5.2. Domains and ranges of functions                      | 5.2.1. Domains and ranges of functions                                                                                                                                        |
|                           |                                                           | 5.2.2. Concept and notation of interval, conversion between sets and intervals notations                                                                                      |
|                           | 5.3. Graphs of functions and their transformations        | 5.3.1. Definition of graph of function                                                                                                                                        |
|                           |                                                           | 5.3.2. Graphs of basic functions (constant function, linear function, quadratic function, reciprocal function, absolute value function) and their properties                  |
|                           |                                                           | 5.3.3. Transformations of graphs of functions (vertical translation, horizontal translation, reflection in the $x$ -axis and $y$ -axis, vertical scaling, horizontal scaling) |
|                           | 5.4. Composite functions                                  | 5.4.1. Definition and methods to find composite functions                                                                                                                     |

|                      |                                                                                    |                                                                                                          |
|----------------------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
|                      | 5.5. One-to-one function, surjective function, bijective function                  | 5.5.1. Definitions and determinations of one-to-one function, surjective function and bijective function |
|                      | 5.6. Inverse functions                                                             | 5.6.1. Definition of inverse function, criteria of the existence of inverse functions                    |
|                      |                                                                                    | 5.6.2. Methods to find of inverse functions                                                              |
|                      |                                                                                    | 5.6.3. Graphs of inverse functions                                                                       |
| 6. Inequalities      | 6.1. Inequalities and their properties                                             | 6.1.1. Concept of inequalities and their properties                                                      |
|                      |                                                                                    | 6.1.2. Comparison of two expressions                                                                     |
|                      | 6.2. Quadratic inequality in one variable                                          | 6.2.1. Solution of quadratic inequality in one variable                                                  |
|                      |                                                                                    | 6.2.2. Solution of a system of quadratic inequalities in one variable                                    |
|                      | 6.3. Fractional inequality                                                         | 6.3.1. Solution of fractional inequality                                                                 |
|                      | 6.4. Linear inequalities in two variables                                          | 6.4.1. Graphical solutions of linear inequalities in two variables                                       |
|                      |                                                                                    | 6.4.2. Graphical solutions of systems of linear inequalities in two variables                            |
|                      |                                                                                    | 6.4.3. Graphical meaning of linear inequality in two variables                                           |
|                      | 6.5. Linear programming                                                            | 6.5.1. Solve problems of linear programming by systems of linear inequalities in two variables           |
| 7. Logic             | 7.1. Statements                                                                    | 7.1.1. Statements, implications                                                                          |
|                      | 7.2. Logical connectors “not”, “and”, “or”                                         | 7.2.1. Meaning of negation, and, or                                                                      |
|                      | 7.3. Universal quantifier and existential quantifier                               | 7.3.1. Universal quantifier, counterexample, existential quantifier                                      |
|                      | 7.4. Sufficient condition, necessary condition, necessary and sufficient condition | 7.4.1. Meanings of sufficient condition, necessary condition, necessary and sufficient condition         |
|                      | 7.5. Argument                                                                      | 7.5.1. Premise, conclusion, valid argument                                                               |
| 8. Degree and Radian | 8.1. Concept of arbitrary angles and their measurements                            | 8.1.1. Definition of angle, arbitrary angles, units of angle (degree, radian)                            |
|                      |                                                                                    | 8.1.2. Conversion between degree and radian                                                              |
|                      | 8.2. Arc length and area of sector                                                 | 8.2.1. Arc length formula, area of sector formula                                                        |
|                      |                                                                                    | 8.2.2. Problems related to arc length and sector                                                         |

|                                                          |                                                                        |                                                                                                                                                                                                        |
|----------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9. Trigonometric Functions of Arbitrary Angles           | 9.1. Trigonometric functions of arbitrary angles                       | 9.1.1. Definition of quadrant angle, trigonometric functions of arbitrary angles and associated angle                                                                                                  |
|                                                          |                                                                        | 9.1.2. Values of trigonometric functions of arbitrary angles and their positivity and negativity                                                                                                       |
|                                                          |                                                                        | 9.1.3. Values of trigonometric functions of special angles                                                                                                                                             |
|                                                          | 9.2. Induced formulas of trigonometric functions                       | 9.2.1. Relationship between the values of trigonometric functions of $-\theta$ 、 $90^\circ \pm \theta$ 、 $180^\circ \pm \theta$ 、 $270^\circ \pm \theta$ 、 $360^\circ \pm \theta$ and that of $\theta$ |
|                                                          | 9.3. Graphs of trigonometric functions                                 | 9.3.1. Graphs, domains, ranges and periods of trigonometric functions                                                                                                                                  |
|                                                          |                                                                        | 9.3.2. Features of the graphs of trigonometric functions                                                                                                                                               |
|                                                          |                                                                        | 9.3.3. Transformations of the graphs of trigonometric functions                                                                                                                                        |
|                                                          | 9.4. Inverse trigonometric functions                                   | 9.4.1. Definition of inverse trigonometric functions and related ranges                                                                                                                                |
| 10. Applications of Trigonometry                         | 10.1. Sine rule                                                        | 10.1.1. Sine rule and its applications                                                                                                                                                                 |
|                                                          | 10.2. Cosine rule                                                      | 10.2.1. Cosine rule and its applications                                                                                                                                                               |
|                                                          | 10.3. Areas of triangles                                               | 10.3.1. Formulas for areas of triangles<br><br>(area = $\frac{1}{2}ab \sin C$ , Heron's Formula)                                                                                                       |
|                                                          |                                                                        |                                                                                                                                                                                                        |
|                                                          | 10.4. Measurement problems                                             | 10.4.1. Definitions of angle of elevation, angle of depression and bearing                                                                                                                             |
|                                                          |                                                                        | 10.4.2. Measurement problems on trigonometry in the plane                                                                                                                                              |
| 11. Trigonometric Identities and Trigonometric Equations | 11.1. Basic identities of trigonometric functions of coterminal angles | 11.1.1. Reciprocal relation, quotient relation and square relation of trigonometric functions of coterminal angles                                                                                     |
|                                                          |                                                                        | 11.1.2. Proofs of trigonometric identities                                                                                                                                                             |
|                                                          | 11.2. Sum and difference of two angles of trigonometric functions      | 11.2.1. Simplifying of the formulas of trigonometric functions (sine, cosine and tangent of the sum and difference of two angles) and proofs of trigonometric identities, angles between two lines     |
|                                                          | 11.3. Double angle formulas                                            | 11.3.1. Simplifying of double angle formulas of trigonometric functions and proofs of trigonometric identities                                                                                         |

|                            |                                                  |                                                                                                                    |
|----------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
|                            | 11.4. Trigonometric equations                    | 11.4.1. Conditional solutions of trigonometric equations, solve equations in the form of $a \sin x + b \cos x = c$ |
| 12. Indices and Logarithms | 12.1. Exponential functions                      | 12.1.1. Definition of index and its rules of operations                                                            |
|                            |                                                  | 12.1.2. Definition of exponential function, graphs of exponential functions and their properties                   |
|                            | 12.2. Logarithmic functions                      | 12.2.1. Definition, properties of logarithm and its rules of operations                                            |
|                            |                                                  | 12.2.2. Formula of changing bases for logarithm                                                                    |
|                            |                                                  | 12.2.3. Definition of logarithmic function, graphs of logarithmic functions and their properties                   |
|                            | 12.3. Exponential and logarithmic equations      | 12.3.1. Solution of exponential equation                                                                           |
|                            |                                                  | 12.3.2. Solution of logarithmic equation                                                                           |
| 13. Sequences and Series   | 13.1. Sequences and series                       | 13.1.1. Definitions of sequence and series, find general terms                                                     |
|                            |                                                  | 13.1.2. Representation of the symbol $\Sigma$                                                                      |
|                            | 13.2. Arithmetic sequences and arithmetic series | 13.2.1. Definition, first term, common difference and general term of arithmetic sequence                          |
|                            |                                                  | 13.2.3. Meaning of arithmetic mean                                                                                 |
|                            |                                                  | 13.2.3. Formula for the sum of arithmetic sequence                                                                 |
|                            | 13.3. Geometric sequences and geometric series   | 13.3.1. Definition, first term, common ratio and general term of geometric sequence                                |
|                            |                                                  | 13.3.2. Meaning of geometric mean                                                                                  |
|                            |                                                  | 13.3.3. Formula for the sum of geometric sequence                                                                  |
|                            |                                                  | 13.3.4. Definition of infinite series, sum of infinite geometric series                                            |
|                            | 13.4. Compound interest and annuity              | 13.4.1. Problems of compound interest and annuity                                                                  |
| 14. Determinants           | 14.1. Determinants                               | 14.1.1. Definitions of first order, second order and third order determinants                                      |
|                            | 14.2. Properties of determinants                 | 14.2.1. Properties of determinants                                                                                 |
| 15. Matrices               | 15.1. Matrices                                   | 15.1.1. Definitions of matrix, equal matrix, zero matrix, identity matrix and transpose matrix                     |
|                            | 15.2. Operations of matrices                     | 15.2.1. Addition and subtraction of matrices                                                                       |
|                            |                                                  | 15.2.2. Scalar multiplication of matrices                                                                          |

|                    |                                                                |                                                                                                                                                    |
|--------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
|                    |                                                                | 15.2.3. Multiplication of matrices                                                                                                                 |
|                    | 15.3. Inverse matrices and their applications                  | 15.3.1. Definition of inverse matrices                                                                                                             |
|                    |                                                                | 15.3.2. Inverse matrices of second order and third order square matrices                                                                           |
|                    | 15.4. Systems of linear equations                              | 15.4.1. Apply inverse matrix to solve systems of linear equations                                                                                  |
| 16. Circles        | 16.1. Equations of loci                                        | 16.1.1. Definition of locus                                                                                                                        |
|                    | 16.2. Equations of circles                                     | 16.2.1. Definition of circle, standard equation of circle, general equation of circle, find the centre and radius from the equation of a circle    |
|                    | 16.3. Relationship between the positions of points and circles | 16.3.1. Relationship between the positions of points and circles, the longest and shortest distances from a point to a circle                      |
|                    | 16.4. Relationship between the positions of lines and circles  | 16.4.1. Relationship between the positions of lines and circles (tangent to, intersect, disjoint), length of tangent                               |
| 17. Plane Vectors  | 17.1. Vectors                                                  | 17.1.1. Definitions of vector, scalar, zero vector, equal vector and inverse vector                                                                |
|                    |                                                                | 17.1.2. Triangle law of vector addition, parallelogram law of vector addition, subtraction of vectors                                              |
|                    |                                                                | 17.1.3. Scalar multiplication of vectors                                                                                                           |
|                    | 17.2. Vectors in the Cartesian coordinate system               | 17.2.1. Definition of position vector, representations using coordinates and unit vectors, magnitudes of vectors, applications of position vectors |
|                    | 17.3. Simple applications of plane vectors                     | 17.3.1. Midpoint rule, proportion rule                                                                                                             |
| 18. Solid Geometry | 18.1. Solid figures                                            | 18.1.1. Polyhedron, regular polyhedron, prism, pyramid, right circular cylinder, right circular cone, sphere                                       |
|                    | 18.2. Angles between straight lines and planes                 | 18.2.1. Relationship between a straight line and a plane                                                                                           |
|                    |                                                                | 18.2.2. The angle formed by a line and a plane                                                                                                     |
|                    | 18.3. Angles between two planes                                | 18.3.1. Relationship between two planes                                                                                                            |
|                    |                                                                | 18.3.2. The angle formed by two planes                                                                                                             |
|                    | 18.4. Application problems of solid geometry                   | 18.4.1. Problems related to solid geometry                                                                                                         |

|                                   |                                                                  |                                                                                                                                              |
|-----------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 19. Permutations and Combinations | 19.1. Addition principle and multiplication principle            | 19.1.1. Concepts of addition principle and multiplication principle                                                                          |
|                                   | 19.2. Permutations and formula of the number of permutations     | 19.2.1. Formula of the number of permutations and problems related to linear permutations                                                    |
|                                   | 19.3. Permutations of different objects with repetitions allowed | 19.3.1. Permutations of different objects with repetitions allowed                                                                           |
|                                   | 19.4. Circular permutations of different objects                 | 19.4.1. Formula of the number of circular permutations and problems related to circular permutations                                         |
|                                   | 19.5. Permutations of objects when not all objects are distinct  | 19.5.1. Permutations of objects when not all objects are distinct                                                                            |
|                                   | 19.6. Combinations and formula of the number of combinations     | 19.6.1. Formula of the number of combinations, problems related to combinations                                                              |
| 20. Binomial Theorem              | 20.1. Binomial theorem with natural number exponents             | 20.1.1. Binomial theorem with natural number exponents and its applications                                                                  |
|                                   | 20.2. General terms of binomial expansions                       | 20.2.1. General terms of binomial expansions                                                                                                 |
| 21. Statistics                    | 21.1. Central tendencies                                         | 21.1.1. Meanings of central tendencies                                                                                                       |
|                                   |                                                                  | 21.1.2. Advantages and disadvantages of different central tendencies, influences on central tendencies when a set of data is changed         |
|                                   | 21.2. Measures of dispersion                                     | 21.2.1. Meanings of measures of dispersion                                                                                                   |
|                                   |                                                                  | 21.2.2. Advantages and disadvantages of different measures of dispersion, influences on measures of dispersion when a set of data is changed |
|                                   | 21.3. Boxplot                                                    | 21.3.1. Concept of outlier                                                                                                                   |
|                                   |                                                                  | 21.3.2. Boxplot                                                                                                                              |
|                                   | 21.4. Statistical index                                          | 21.4.1. Meanings of weighted mean, statistical index and composite index                                                                     |
|                                   |                                                                  | 21.4.2. Calculations of statistical index and composite index                                                                                |

|                                              |                                                      |                                                                                                                                  |
|----------------------------------------------|------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 22. Probabilities                            | 22.1. Sample spaces and events                       | 22.1.1. Concept of random phenomena, concepts of and methods to find sample spaces and events                                    |
|                                              | 22.2. Definition of probability                      | 22.2.1. Classical definition of probability                                                                                      |
|                                              | 22.3. Addition principle                             | 22.3.1. Concepts of mutually and non-mutually exclusive events, addition principle of mutually and non-mutually exclusive events |
|                                              |                                                      | 22.3.2. Concept of complementary events and its calculations of probabilities                                                    |
|                                              | 22.4. Multiplicative principle                       | 22.4.1. Concept of independent event, multiplication principle of independent events                                             |
|                                              |                                                      | 22.4.2. Concept of dependent event, definition and calculations of conditional probabilities                                     |
|                                              | 22.5. Mathematical expected values                   | 22.5.1. Meaning of mathematical values and its calculations                                                                      |
| 23. Linear Regression                        | 23.1. Correlation coefficient                        | 22.6.1. Concept and applications of normal distributions                                                                         |
|                                              |                                                      | 23.1.1. Scatter plot of two dimensional data                                                                                     |
|                                              |                                                      | 23.1.2. Definition and method to find correlation coefficient                                                                    |
|                                              | 23.2. Regression line                                | 23.1.3. Meaning of the degree of correlation                                                                                     |
|                                              |                                                      | 23.2.1. Definitions of independent variable and dependent variable                                                               |
| 24. Limits                                   | 24.1. Limits of sequences                            | 23.2.2. Using the least squares method to build linear regression model                                                          |
|                                              | 24.2. Limits of functions                            | 24.1.1. Concept, properties and calculations of limits of sequences                                                              |
|                                              |                                                      | 24.2.1. Concept of limits of functions, left hand limits, right hand limits                                                      |
|                                              | 24.3. Rules of operations of the limits of functions | 24.2.2. Limits of functions when $x \rightarrow \infty$ or $x \rightarrow -\infty$                                               |
|                                              |                                                      | 24.3.1. Rules of operations of the limits of functions, examples when limits do not exist                                        |
| 25. Differentiation and Its Applications (I) | 25.1. Derivatives                                    | 24.4.1. Continuity of functions and its determination                                                                            |
|                                              |                                                      | 25.1.1. Definition of derivative, apply definition of derivative to find derivative                                              |
|                                              |                                                      | 25.1.2. Relationship between differentiable and continuous                                                                       |

|                                               |                                                    |                                                                                                                          |
|-----------------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
|                                               | 25.2. Rules of differentiation                     | 25.2.1. Rules of differentiation of constant multiples, sums and differences, products and divisions of functions        |
|                                               |                                                    | 25.2.2. Derivatives of power functions                                                                                   |
|                                               | 25.3. Chain rule                                   | 25.3.1. Chain rule - rule of differentiation of composite functions                                                      |
|                                               | 25.4. Higher order derivatives                     | 25.4.1. Higher order derivatives and its applications                                                                    |
|                                               | 25.5. Tangents and normals                         | 25.5.1. Tangent and normal to a curve at a point                                                                         |
|                                               | 25.6. Increasing and decreasing of functions       | 25.6.1. Concept of monotone functions                                                                                    |
|                                               |                                                    | 25.6.2. Criteria of increasing and decreasing of functions                                                               |
|                                               | 25.7. Local extrema of functions                   | 25.7.1. Local maximum and minimum values of functions                                                                    |
|                                               |                                                    | 25.7.2. Ways to find stationary points, apply first derivative test or second derivative test to determine local extrema |
|                                               |                                                    | 25.7.3. Problems related to local extrema                                                                                |
|                                               | 25.8. Graph sketching of curves                    | 25.8.1. Convexities of curves and points of inflexions, graph sketching of curves                                        |
| 26. Differentiation and Its Applications (II) | 25.9. Global extrema of functions                  | 25.9.1. Global maximum and minimum values of functions                                                                   |
|                                               | 25.10. Rates of change and related rates of change | 25.10.1. Problems related to rates of change and related rates of change                                                 |
|                                               | 25.11. First order approximation of functions      | 25.11.1. First order approximation of functions and related problems                                                     |
|                                               | 26.1. Differentiation of implicit functions        | 26.1.1. Differentiation of implicit functions                                                                            |
|                                               | 26.2. Differentiation of trigonometric functions   | 26.2.1. Value of $\lim_{x \rightarrow 0} \frac{\sin x}{x}$                                                               |
|                                               |                                                    | 26.2.2. Derivatives of trigonometric functions                                                                           |
|                                               | 26.3. Differentiation of logarithmic functions     | 26.3.1. Value of $\lim_{x \rightarrow 0} (1+x)^{\frac{1}{x}}$                                                            |
|                                               |                                                    | 26.3.2. Derivative of natural logarithm function, derivatives of general logarithmic functions                           |

|                                             |                                                                 |                                                                                                                                            |
|---------------------------------------------|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | 26.4. Differentiation of exponential functions                  | 26.4.1. Derivative of natural exponential function, derivatives of general exponential functions                                           |
|                                             | 26.5. L'Hôpital's Rule                                          | 26.5.1. L'Hôpital's Rule ( $\frac{0}{0}$ indeterminate form and $\frac{\infty}{\infty}$ indeterminate form)                                |
| 27. Indefinite Integrals                    | 27.1. Indefinite integrals-inverse operation of differentiation | 27.1.1. Relationship between indefinite integrals and differentiation                                                                      |
|                                             | 27.2. Rules of operations of indefinite integrals               | 27.2.1. Basic integration formulas, rule of taking out constant and rule of integrate separate terms, applications of indefinite integrals |
|                                             | 27.3. Integration by substitution                               | 27.3.1. Apply integration by substitution to find indefinite integrals                                                                     |
|                                             | 27.4. Integration by partial fractions                          | 27.4.1. Decompose fractions with denominators being product of linear factors, power of linear factors into partial fractions              |
|                                             |                                                                 | 27.4.2. Apply partial fractions to find integrations of fractions                                                                          |
| 28. Definite Integrals and Its Applications | 28.1. Concepts of definite integral                             | 28.1.1. Definition of definite integral                                                                                                    |
|                                             |                                                                 | 28.1.2. Relationship between definite integral and indefinite integral, Fundamental Theorem of Calculus                                    |
|                                             | 28.2. Properties and calculations of definite integrals         | 28.2.1. Properties and calculations of definite integrals, apply integration by substitution to find definite integrals                    |
|                                             | 28.3. Areas                                                     | 28.3.1. Areas of the regions bounded by curves                                                                                             |
|                                             | 28.4. Volumes of solids of revolution                           | 28.4.1. Volumes of solids generated when a region is revolved about the coordinate axes                                                    |

## 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 Mathematics. The connotations of these domains are further explained in Table 6. Table 7 and Table 8 are correspondence tables mapping examples of content standards and learning standards for reference in lesson plans.

**Table 5***Learning Standards*

| <b>Domain</b> | <b>Cognitive (C)</b>                                                              | <b>Psychomotor (P)</b>                                                                          | <b>Affective (A)</b>                                               |
|---------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| Item          | Ca Mathematical Element<br>Cb Mathematical Knowledge<br>Cc Mathematical Procedure | Pa Mathematizing<br>Pb Analysing<br>Pc Problem-solving<br>Pd Communicating<br>Pe Applying Tools | Aa Learning Confidence<br>Ab Motive<br>Ac Mathematical Disposition |

**Table 6***Description of Items in the Learning Standards*

| <b>Domain</b>   | <b>Item</b>                 | <b>Descriptions</b>                                                                                                                                                   |
|-----------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 relationship 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 the ability of 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 Mathematical Disposition | I. Indicates the ability to think independently, understand the nature and value of mathematics, and apply to one's life.                                             |

**Table 7**

*First Example of the Alignment Between Content Standards and Learning Standards*

| <div>Learning Standards</div> <div>Content Standards</div>                                                                                                 | Cognitive (C)                                                                           | Psychomotor (P)                                                    | Affective (A)                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------|-----------------------------------------------------------|
|                                                                                                                                                            | CcI<br>Indicates formation procedures and steps of mathematical elements and knowledge. | PaI<br>Indicates arithmetic, algorithm, modelling and visualising. | AaI<br>Indicates self-confidence in learning mathematics. |
| 3.1.2 Four arithmetic operations of polynomials in one variable (addition and subtraction, multiplication and division), concepts of factors and multiples | Understand the concept and relationship of factors and multiples.                       | Able to operate the arithmetic of polynomials.                     | Perform the procedure with confidence and patience.       |

**Table 8**

*Second Example of the Alignment Between Content Standards and Learning Standards*

| <div>Learning Standards</div> <div>Content Standards</div>                                                                                                                        | Cognitive (C)                                                                                                               | Psychomotor (P)                                                                      | Affective (A)                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                   | CbI<br>Indicates relationship between mathematical elements. Students understand mathematical concepts, theorems, and laws. | PbI<br>Indicates the ability of analysing problems and making reasonable inferences. | AcI<br>Indicates the ability to think independently, understand the nature and value of mathematics, and apply to one's life. |
| 21.2.2. Advantages and disadvantages of different central tendencies, influences on central tendencies when a set of data is uniformly changed and meanings of central tendencies | Understand meanings of central tendencies.                                                                                  | Able to make reasonable inference on meanings of central tendencies.                 | Curious in various interpretation of central tendencies.                                                                      |

## 8. Pedagogical Suggestions

The Mathematics course comprises 28 chapters, the period allocation for each chapter is indicated in Table 9. In addition, each chapter can be allocated a flexible 1-2 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 9**

*Periods Allocation Recommendation for Mathematics*

| Level                                                | Chapter | Chapter Title                                                         | Period Allocation Recommendation |
|------------------------------------------------------|---------|-----------------------------------------------------------------------|----------------------------------|
| Senior Middle One A                                  | 1       | Cartesian Coordinate System and Straight Lines                        | 15 - 18                          |
|                                                      | 2       | Quadratic Equations in One Variable and Graphs of Quadratic Functions | 10 - 12                          |
|                                                      | 3       | Polynomials                                                           | 18 - 20                          |
|                                                      | 4       | Irrational Expressions                                                | 8 - 10                           |
|                                                      | 5       | Functions                                                             | 15 - 17                          |
|                                                      | 6       | Inequalites                                                           | 18 - 20                          |
| Senior Middle One B                                  | 7       | Logic                                                                 | 5 - 7                            |
|                                                      | 8       | Degree and Radian                                                     | 6                                |
|                                                      | 9       | Trigonometric Functions of Arbitrary Angles                           | 15                               |
|                                                      | 10      | Applications of Trigonometry                                          | 12 - 15                          |
|                                                      | 11      | Trigonometric Identities and Trigonometric Equations                  | 18 - 20                          |
|                                                      | Total   |                                                                       | 140 - 160                        |
| After increasing 1-2 flexible periods in 11 chapters |         |                                                                       | 151 - 182                        |
| Senior Middle Two A                                  | 12      | Indices and Logarithms                                                | 10 - 12                          |
|                                                      | 13      | Sequences and Series                                                  | 20                               |
|                                                      | 14      | Determinants                                                          | 5- 6                             |
|                                                      | 15      | Matrices                                                              | 12 - 15                          |
|                                                      | 16      | Circles                                                               | 12 - 15                          |
|                                                      | 17      | Plane Vectors                                                         | 10 - 12                          |
|                                                      | 18      | Solid Geometry                                                        | 10                               |
| Senior Middle Two B                                  | 19      | Permutations and Combinations                                         | 12 - 15                          |
|                                                      | 20      | Binomial Theorem                                                      | 5                                |
|                                                      | 21      | Statistics                                                            | 15 - 18                          |
|                                                      | 22      | Probabilities                                                         | 15 - 18                          |
|                                                      | 23      | Linear Regression                                                     | 8 - 10                           |
|                                                      | Total   |                                                                       | 134 - 156                        |
| After increasing 1-2 flexible periods in 12 chapters |         |                                                                       | 146 - 180                        |
| Senior Middle Three A                                | 24      | Limits                                                                | 5 - 7                            |
|                                                      | 25      | Differentiation and Its Applications (I)                              | 26 - 33                          |
|                                                      | 26      | Differentiation and Its Applications (II)                             | 14 - 17                          |

|                                                     |    |                                         |                  |
|-----------------------------------------------------|----|-----------------------------------------|------------------|
| Senior                                              | 27 | Infinite Integrals                      | 23               |
| Middle                                              | 28 | Definite Integrals and Its Applications | 12 - 15          |
| Three B                                             |    |                                         |                  |
|                                                     |    | Total                                   | 80 - 95          |
| After increasing 1-2 flexible periods in 5 chapters |    |                                         | 85 - 105         |
| <b>Total of three senior middle level</b>           |    |                                         | <b>382 - 467</b> |

“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.

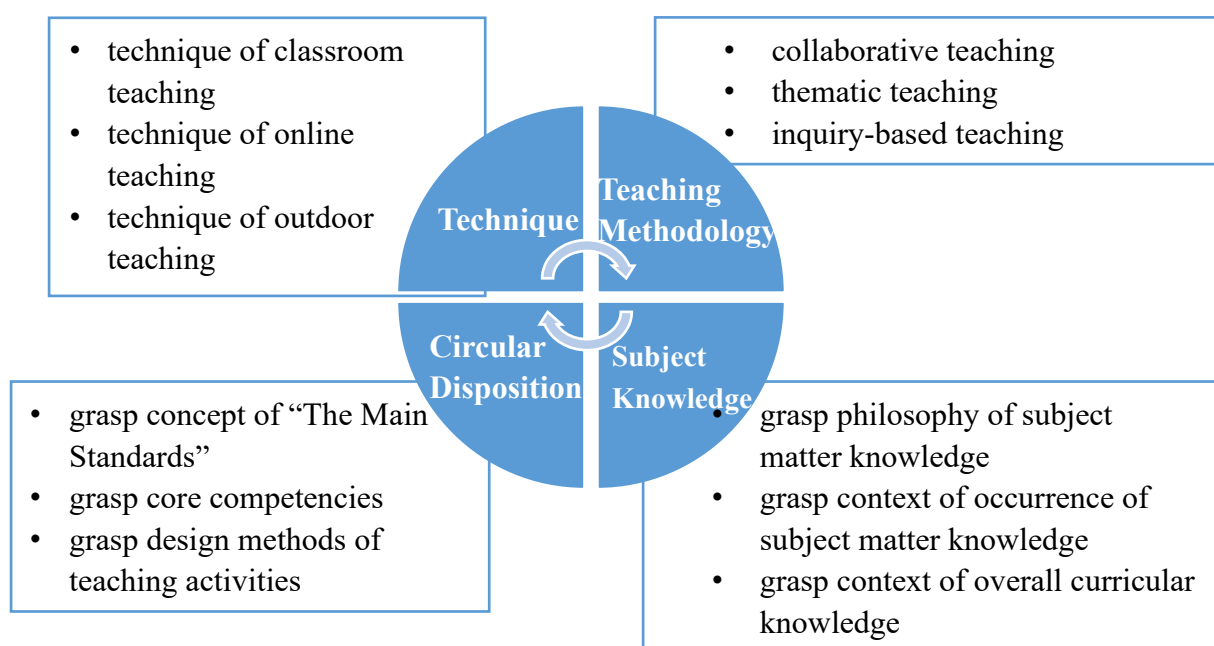
Second, teaching methods. Orthodox teaching is not “one-size-fits-all”, instead “student-centered learning” is more recognized nowadays. The *Main Standards* emphasizes the competency of exploring knowledge on oneself, thus teachers should adjust learning roadmap, so that students are given more opportunity 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. 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 10) indicates the performance standards of cognitive, affective, and psychomotor, expressed at different levels accordingly. Table 11 and Table 12 indicate examples 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 10**

*Performance Standards of Cognitive, Psychomotor and Affective*

| Domain           | Item                          | Level         | Performance Standards                                               |
|------------------|-------------------------------|---------------|---------------------------------------------------------------------|
| Cognitive<br>(C) | Ca<br>Mathematical<br>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<br>Mathematical<br>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<br>Mathematical<br>Procedure | 1. Remember       | Write the steps.                                                                           |
|                    |                                 | 2. Understand     | Understand the sequence and relationship of the steps.                                     |
|                    |                                 | 3. Apply          | Apply the steps independently.                                                             |
|                    |                                 | 4. Analyse        | Reorganize, ensure the relationship between steps.                                         |
|                    |                                 | 5. Evaluate       | Determine the reasonableness of steps.                                                     |
|                    |                                 | 6. Create         | Generate activity related to mathematical procedure.                                       |
| Psychomotor<br>(P) | Pa<br>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<br>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<br>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<br>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<br>Applying Tools  | 1. Imitation      | Imitate others ways of using mathematical tool.                                                                                                       |
|  |                       | 2. Manipulation   | Use mathematical tools independently.                                                                                                                 |

|                  |                                |                                 |                                                                                                                                           |
|------------------|--------------------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Affective<br>(A) |                                | 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.                                                          |
|                  | Aa<br>Learning Confidence      | 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.                                                                                       |
|                  | Ab<br>Motive                   | 1. Receiving                    | Learn passively from teachers or textbooks.                                                                                               |
|                  |                                | 2. Responding                   | Begin to show curiosity about certain mathematical knowledge and processes.                                                               |
|                  |                                | 3. Valuing                      | Actively explore the principles behind mathematical knowledge and processes.                                                              |
|                  |                                | 4. Organising & Conceptualising | Shows a strong curiosity about mathematical knowledge and processes, and takes initiative to explore them in depth.                       |
|                  |                                | 5. Characterising by Values     | Actively explores higher-level mathematical knowledge and processes, achieving self-fulfillment in the process.                           |
|                  | Ac<br>Mathematical Disposition | 1. Receiving                    | Recognize the connection between mathematics and everyday life.                                                                           |
|                  |                                | 2. Responding                   | Actively explore the relationship between mathematics and life.                                                                           |
|                  |                                | 3. Valuing                      | Develop an understanding of the rigor and systematic nature of mathematics, learn to reflect, and view issues from multiple perspectives. |

|  |  |                                 |                                                                                                   |
|--|--|---------------------------------|---------------------------------------------------------------------------------------------------|
|  |  | 4. Organising & Conceptualising | Integrate mathematical ways of thinking with other values to develop your own perspectives.       |
|  |  | 5. Characterising by Values     | Integrate mathematical ways of thinking with other values and apply them to real-life situations. |

**Table 11**

*First Example of the Alignment Between Content Standards, Learning Standards and Performance Standards*

| <div style="text-align: center;">Learning Standards</div> <div style="text-align: center;">Content Standards</div>                                          | Cognitive (C)                                                                           | Psychomotor (P)                                                    | Affective (A)                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                             | CcI<br>Indicates formation procedures and steps of mathematical elements and knowledge. | PaI<br>Indicates arithmetic, algorithm, modelling and visualising. | AaI<br>Indicates self-confidence in learning mathematics.                                                            |
| 3.1.2. Four arithmetic operations of polynomials in one variable (addition and subtraction, multiplication and division), concepts of factors and multiples | 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.<br><br>(Cc4 Analyse)                 | Complete mathematical task accurately.<br><br>(Pa3 Precision)      | Keen on learning mathematics, achieve breakthroughs in limitation in learning.<br>(Aa4 Organising & Conceptualising) |

**Table 12**

*Second Example of the Alignment Between Content Standards, Learning Standards and Performance Standards*

| <div>Learning Standards</div> <div>Content Standards</div>                                                                                                                        | Cognitive (C)                                                                                                               | Psychomotor (P)                                                                                                                                           | Affective (A)                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                   | CbI<br>Indicates relationship between mathematical elements. Students understand mathematical concepts, theorems, and laws. | PbI<br>Indicates the ability of analysing problems and making reasonable inferences.                                                                      | AcI<br>Indicates the ability to think independently, understand the nature and value of mathematics, and apply to one's life.                                  |
| 21.2.2. Advantages and disadvantages of different central tendencies, influences on central tendencies when a set of data is uniformly changed and meanings of central tendencies | Understand meanings of central tendencies.                                                                                  | Able to make reasonable inference on meanings of central tendencies.                                                                                      | Curious in various interpretation of central tendencies.                                                                                                       |
| Performance Standards                                                                                                                                                             | Interpret mathematical concept, theorem and principle.<br><br>(Cb2 Understand)                                              | Analyze different question, interpret various information by interlinking new and old knowledge, and make reasonable inference.<br><br>(Pb4 Articulation) | Develop an understanding of the rigor and systematic nature of mathematics, learn to reflect, and view issues from multiple perspectives.<br><br>(Ac3 Valuing) |

## 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 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 implementing 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 chapter, 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

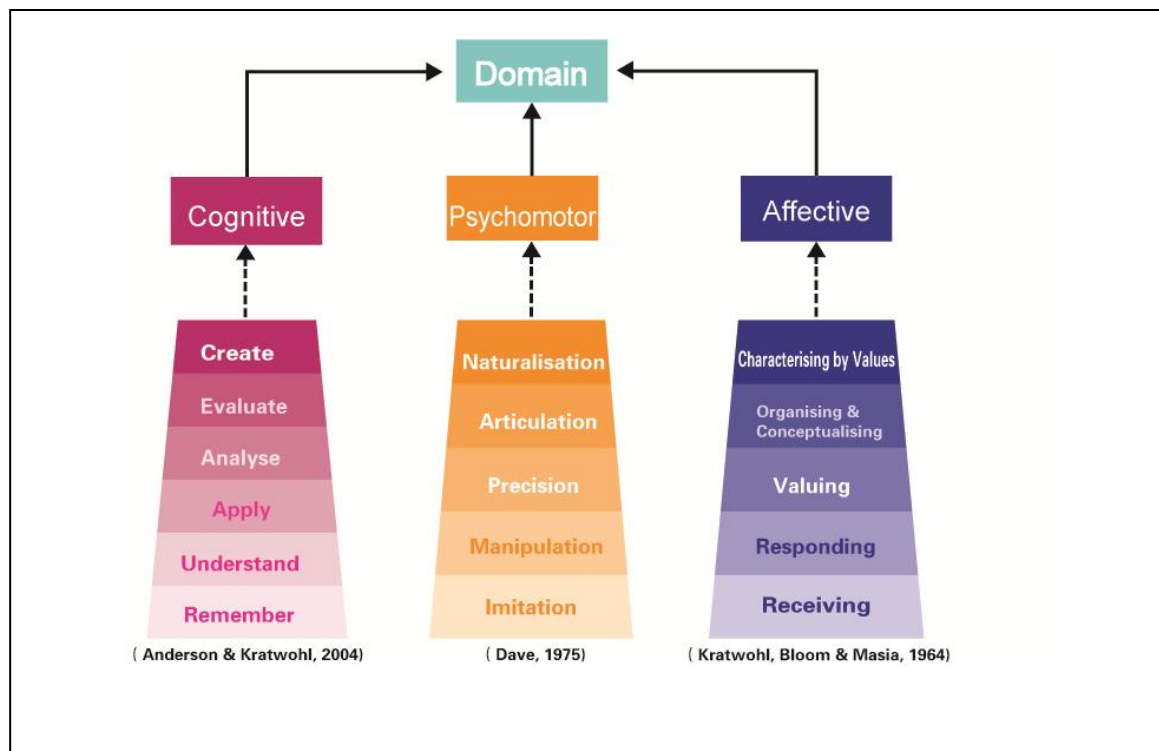
- a. Basic teaching aids: large ruler and compass, sphere model, geometric frame, transparent three-dimensional model, three view drawing, etc.
- b. Basic classroom equipment: black board or white board, computer, projector, screen, sound system, etc.
- c. Multimedia room: enough time to travel back 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 model, 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 middle 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.

## Appendix 1

### Cognitive, Psychomotor and Affective Domains



## Appendix 2

### Template of Performance Standards

| Chapter:         |                   |                             |                      |   |         |
|------------------|-------------------|-----------------------------|----------------------|---|---------|
| Content Standard | Learning Standard |                             | Performance Standard |   |         |
|                  | 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   |