STEINER EDUCATION AUSTRALIA

AUSTRALIAN STEINER CURRICULUM FRAMEWORK 2011

MATHEMATICS HIGH SCHOOL
Extended Curriculum
Stage 3: Year 8

Original ACARA Recognition October 2011

Revisions included in this document:

April 2012 Numbering added to Content Descriptions and Achievement standards to enable cross-referencing

Sept 2014 Changes made to terminology relating to Aboriginal and Torres Strait Islander peoples, as per ACARA guidelines

MATHEMATICS
Extended Curriculum Topics
Stage 3: YEAR 8

Contents:

Platonic Solids

YEAR 8: DEVELOPMENTAL PROFILE OF THE 14 YEAR OLD STUDENT	
DEVELOPMENTAL STAGE	**CURRICULUM APPROACH**
PHYSICAL GROWTH	
In Year 8, the students reach 14 years of age, a significant point in the transition from childhood to adolescence. They often seem awkward in their own bodies and have sometimes lost the gracefulness of childhood. The physical and psychological changes of adolescence are well under way. Acne, 'gangliness', clumsiness and a new vulnerable awareness of their feeling and thought life are some of the characteristics of the adolescent. Growth in height and sexual development is established and noticeable in the boys' breaking voices and the onset of physical maturation and menstruation in the girls.	The traditional age of apprenticeship marks the time to introduce adult themes and more challenging content. Students want to feel that they are being taken seriously and their contributions and ideas are valued. At a time where their bodies and emotional lives are undergoing significant change, it is supportive to encounter Mathematical laws that are established and timeless.
SOCIO-EMOTIONAL DEVELOPMENT	
An independent life of feeling emerges at this age and is often accompanied by emotional turbulence. Gender differences become apparent: girls are able to express and share their feelings in small cohesive groups, while the boys tend to be brash, sullen and 'emotionally illiterate' by comparison. Girls can seem to be overconfident and verbally expressive, while boys can become reticent and uncommunicative.	The content of the lessons should empower students to feel at home in the modern world and lead them to bring all they have learnt into a meaningful world picture. At a time when the emotional life is changeable and turbulent, the students can be afforded a glimpse of a world of mathematical harmony, which reflects forms and laws that have been stable and unchanged for millennia. This offers an opportunity to rekindle a profound sense of awe at the perfection of these archetypal forms.
COGNITIVE MATURATION	
As the critical faculties of students sharpen, the world of ideas acquires new meaning and rules come under scrutiny. Students like reasoning and are reasonable. Their descriptive observational ability is maturing and phenomena can be described that are increasingly complex. Abstract causality can begin to be appreciated.	Students are encouraged to develop their faculties of observation, which is then recorded through descriptive writing and careful illustration. The level of judgement exercised in the consideration of phenomena is a more practical, mechanical judgement with a low level of abstraction.
MORAL CAPACITY	
The students in Class 8 are well and truly immersed in adolescence. As they become teenagers, childhood is increasingly left behind, and there is a real danger that the wonder and awe of their earlier experiences of the world can give way to materialism and cynicism. The possibility arises that new material presented to the students can be viewed with boredom and disengagement. It is an age where students are struggling with distinguishing their own moral stance to issues of the world.	The lessons support and encourage the students' youthful idealism, provide them with inspiring role models and daily opportunities to form their own judgements about experiences they have gained from the lessons. It is important to bring a positive and engaging world picture to fourteen year olds, so that they might find a way to connect with the world and find a meaningful place within it.

Mathematics 8.1 **Change and Rhythm**

The Central Experience of the Content

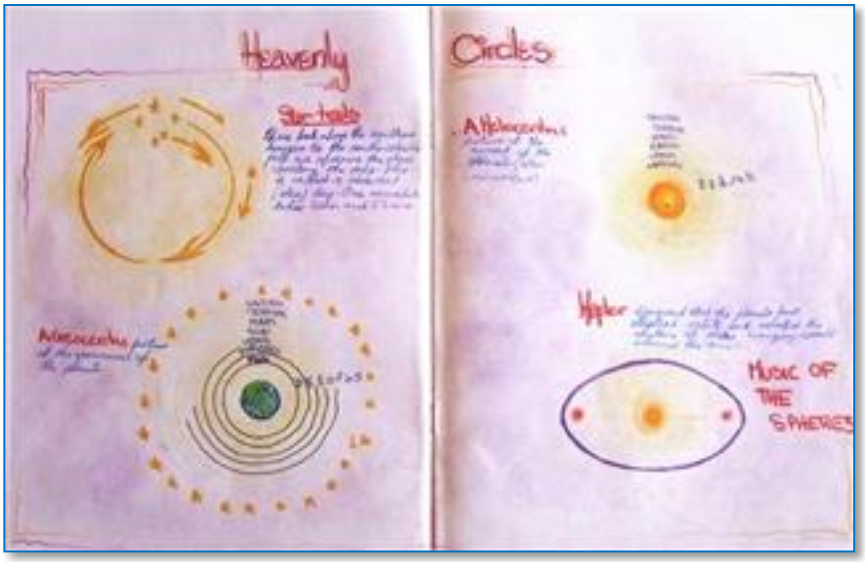
During this topic, the human being is placed within the rhythms of the universe by investigating the relationship of breathing and heartbeat to the Platonic cosmic year, heavenly circles, the seasons, the nature and measurement of time and the circle/spiral of fifths in music.

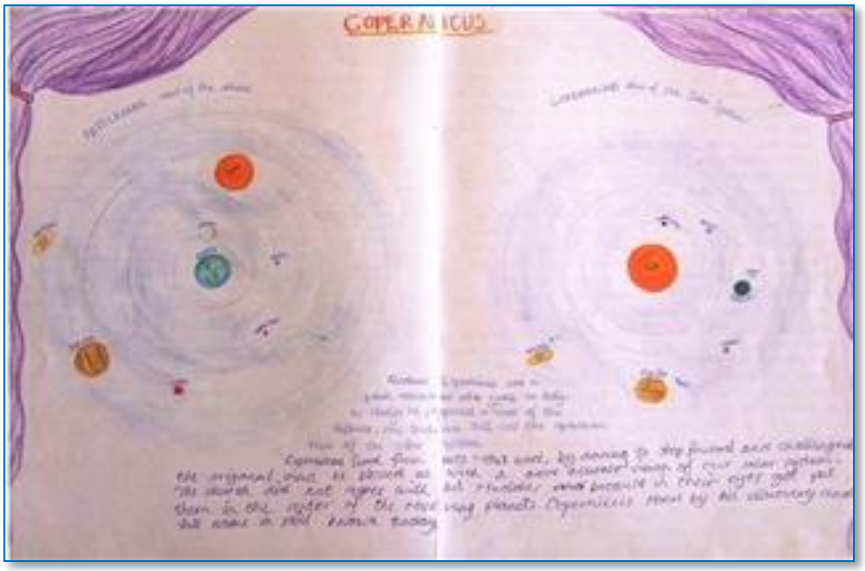
The circle is discussed both as a symbol and as a geometric shape – its diameter, circumference, pi, area etc. are all considered. The curves and forms generated by moving circles, such as the helix and cycloid are also studied.

Future Capacities

This topic seeks to bring to the students both a Mathematical understanding and inner experiences in their relation to the world of cyclical change and rhythm. At a time where they are in danger of losing a reverent picture of the dynamic cosmos that they inhabit, the content of this topic serves to renew their sense of wonder at being part of something far larger and more meaningful than they perhaps realise.

In addition, it is intended that students appreciate the fact that Mathematics has its own intrinsic value and beauty, and that they enjoy experiencing the elegance and diverse applications of the subject.





Content description

Mathematics 8.1 Topic: Change and rhythm

Students will learn to:

1. Develop an appreciation of the relationship between the average number of breaths per day and the Platonic cosmic year in order to feel the place of the human being in the cosmos;
2. Deal with both very small and large numbers, expressing them in scientific notation;
3. Appreciate the change in human consciousness that led from a geocentric to a heliocentric view of the world through an historical study of Copernicus and Kepler;
4. Gain a deeper understanding of the significance of time in human culture and the various ways in which it is measured and recorded;
5. Discover pi and the formulae for circumference and area through a study of the circle;
6. Experience and develop an understanding of the content of this topic both with and without the use of digital technologies.

Content Elaboration

Learning Experiences	Multi-modal and Artistic Activities	Conceptual Knowledge and Skills
Students measure their pulse, count the number of breaths for a given time period, record their findings for each member in the class and arrive at an average figure.	Students could compare their results for the number of breaths per day with the number of years per Platonic year etc.	Students come to an appreciation of the relationship between the human being and the cosmos.
Students are presented with the history of the development of astronomy from Copernicus to Kepler.	Movement, drawing, painting or modelling may be used to represent the geocentric and heliocentric astronomical models.	Students come to an appreciation of the shift in human consciousness that led to the development of a heliocentric astronomy.
Students track the cycles of the moon, discuss the seasons, and learn about various calendar systems.	Different calendar systems could be researched and presented in a variety of ways.	Students come to an understanding of the rationale behind the various ways in which human beings have chosen to represent the passing of time.
Students investigate the relationship between diameter and circumference using different cylinders and string.	Students could experimentally determine the value of pi, and apply it to a range of calculations.	Students come to a direct experience of the discovery and application of transcendental numbers such as pi

Mathematics 8.2 **The Platonic Solids**

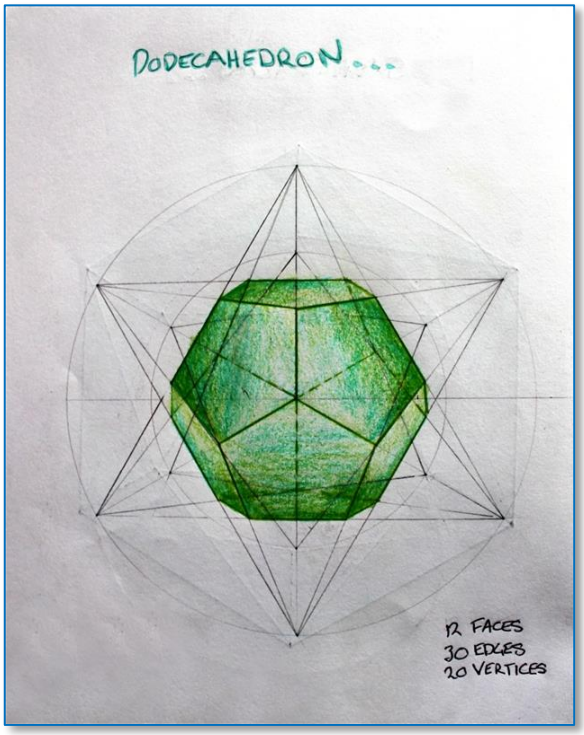
The Central Experience of the Content

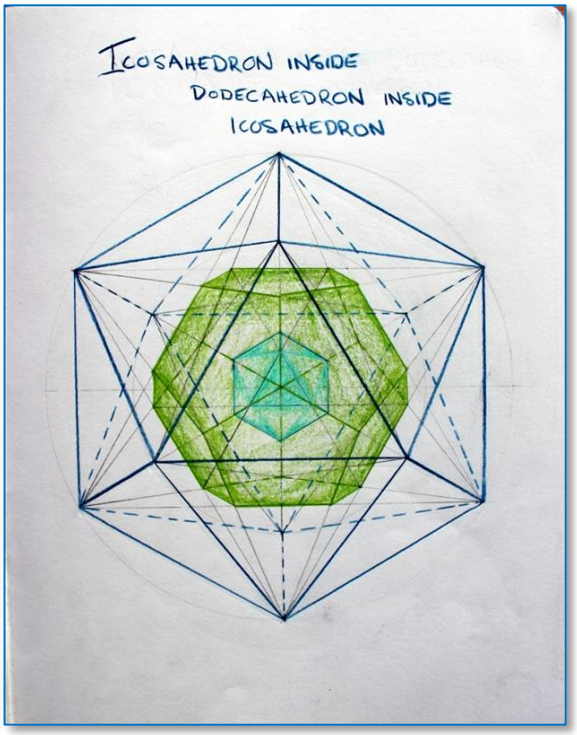
This topic reflects the Ancient Greek idea of the study of geometry as a fundamental pursuit in order to refine the mind and nourish the thinking. The students further develop their skills with drawing equipment in constructing the orthographic projections of the Platonic Solids while gaining insight into the historical and cultural relevance of these forms.

Future Capacities

This topic seeks to bring to the students both a Mathematical understanding and inner experiences in their relation to the Geometry of form. At a time where their bodies and emotional lives are undergoing significant change, it is supportive to encounter Mathematical laws that are established and timeless.

An understanding of the historical significance of the Platonic Solids over millennia of human culture is both engaging and rewarding, and gives students an appreciation of the elegance, value and beauty intrinsic to Mathematics.





Content Organiser

Mathematics 8.2 **Topic: The Platonic Solids**

Students will learn to:

1. Understand the historical and cultural significance of the forms of the Platonic Solids;
2. Develop skill with the drawing equipment through construction of orthographic projections and nets of the Platonic Solids;
3. Experience and develop an understanding of the content of this topic both with and without the use of digital technologies.

Content Elaboration

Learning Experiences	Multi-modal and Artistic Activities	Conceptual Knowledge and Skills
Students revise and practise construction techniques.	Students could revise previous constructions, and practice accuracy and techniques.	Students develop skill in manipulating compass and ruler to produce accurate constructions.
Students become familiar with the properties of polygons by construction and measurement.	Students could construct polygons, write clear, efficient instructions for the construction of polygons, measure and calculate sides and angles.	Students arrive at the rules or theorems relating to polygons.
Students practice tessellation of polygons and then discover the formation of three dimensional polyhedra.	Students could form patterns or mosaics by tessellating polygons individually or in combination, and extend this exercise from two to three dimensions.	Students discover the five regular three dimensional polyhedra that can be formed by tessellation of individual polygons – the Platonic Solids.
Students construct the Platonic solids out of paper or card by tessellating polygons, and count the vertices, edges and faces.	Students discover Euler's formula and experience its application to the Platonic Solids.	Students come to an appreciation of the unique nature of the Platonic Solids in satisfying Euler's formula.
Students discover an historical context of Platonic Solids.	Students could research an historical or cultural aspect of the forms eg Plato, Neolithic stone balls etc.	Students come to an understanding of the significance of the Platonic Solids in terms of their place in history and human culture.
Students practise and develop construction techniques by constructing nets.	Students could construct orthographic projections and nets of each Platonic Solid.	Students understand how the three dimensional forms of the Platonic solids are built up from the two dimensional nets.
Students practise forming the Platonic solids one after the other from the same piece of clay.	Students could model Platonic Solids in clay and investigate the transformations of one Platonic Solid into another through the medium of clay.	Students come to an appreciation of the transformation of form and the concept of duality.

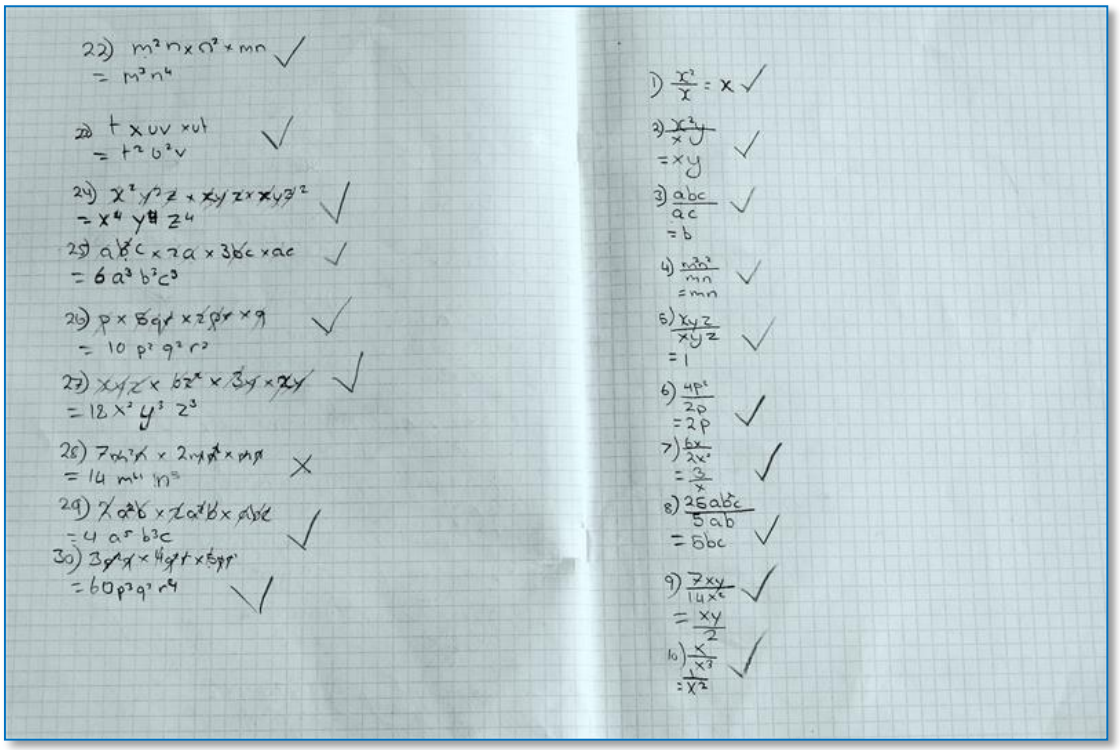
Mathematics 8.3 **Number and Algebra**

The Central Experience of the Content

The study of Algebra is revised, consolidated and extended, with focus on the development of strong foundations in the topic. The students should be led to an appreciation of the power and versatility of Algebra as a Mathematical tool, and develop confidence in its application in a wide variety of contexts.

Future Capacities

The middle school years are an important period of learning, in which the foundations of knowledge of many fundamental disciplines are established. Algebra is a significant Mathematical tool that finds application in the further study of Mathematics, but also appears in the Sciences, Engineering, Technology and Economics, amongst others. A thorough grounding in Algebra is indispensible in many tertiary courses, and provides skills that create a pathway towards continued success in further education, training or employment.



Content Organiser

Mathematics 8.3 **Topic: Number and Algebra**

Students will learn to:

1. Consolidate and extend their knowledge of Algebra by focussing on the commutative, associative and distributive laws;
2. Revise and extend previous work on the Cartesian Plane and linear functions;
3. Simplify more complex algebraic statements involving terms in brackets by paying close attention to the order of operations;
4. Experience relevant practical examples of Algebra through word problems involving time, distance and speed;
5. Factorise, first by seeking a common factor, and then by the application of the difference of two squares;
6. Extend the study of indices and exponents and apply them to the calculation of areas of shapes, surface areas and volumes of various solids;
7. Perform simple surveys and probability experiments;
8. Investigate and compare the use of tables, Venn diagrams and different types of graphs as a means of presenting these data visually, and evaluate their effectiveness in different contexts, such as encountered in the media;
9. Experience and develop an understanding of the content of this topic both with and without the use of digital technologies.

Content Elaboration

Learning Experiences	**Multi-modal and Artistic Activities**	**Conceptual Knowledge and Skills**
Students consolidate and practice the applications of the commutative, associative and distributive laws.	Practical examples and activities could be used to broaden the scope of the students understanding of the Algebraic laws.	Students gain confidence in and appreciation of the power and versatility of the basic Algebraic laws.
Students are introduced to and practice the process of factorisation by seeking a common factor and by the difference of two squares.	Practical examples and activities could be used to broaden the scope of the students understanding of the Algebraic laws.	Students gain confidence in and appreciation of the power and versatility of the basic Algebraic laws.
Students model solids such as prisms, cones, cylinders etc, and develop formulae to calculate their volume.	Students could discover exponents through practical experience and become familiar with incorporating them into increasingly complex problems.	Students appreciate the practical applications of algebraic formulae involving exponents.
Students time themselves running a given distance.	Students could calculate their speed given the distance and the time they took to run it. They experiment with various ways of representing the data that they obtain, and interpret the data by calculating mean, median and mode. They could also be given increasingly challenging problems involving speed, distance and time.	Students have a practical experience of using experimental data to develop a mathematical formula or 'rule', which can then be applied to other problems. Data may also be interpreted by statistical analysis.

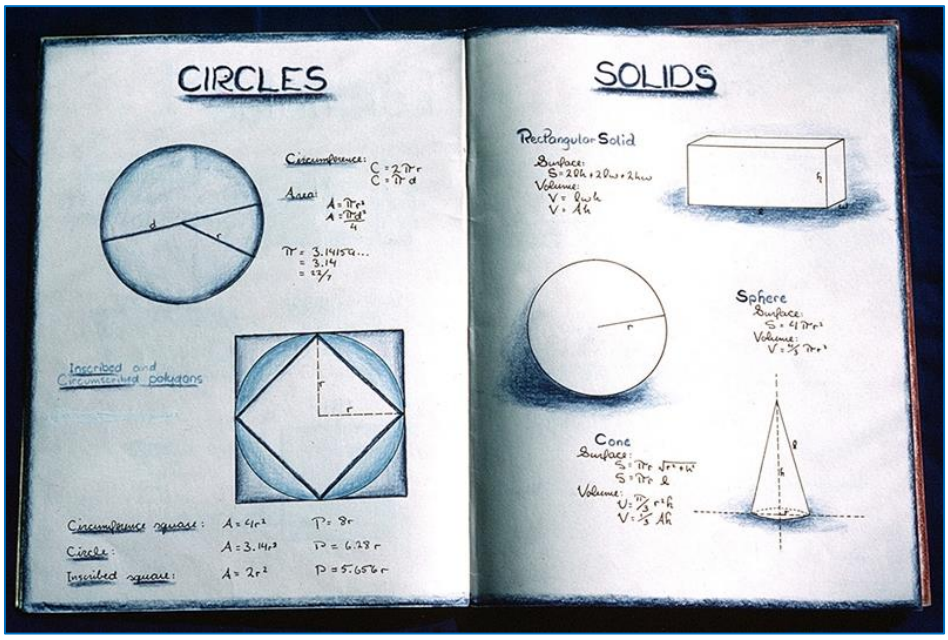
Mathematics 8.4 **Geometry and Measurement**

The Central Experience of the Content

Through dual experiences of construction and calculation, students become familiar with Geometrical forms, rules and proofs. All aspects of shapes and forms are considered, from accurate measurement and construction techniques, through to the calculation of unknown angles, side lengths, areas, volumes and surface areas. Perspective drawing provides an artistic avenue for the expression of these laws.

Future Capacities

The language of space and form is formed and free from emotion, which provides support and stability for the students at a time where their bodies and emotional lives are undergoing significant change. A more concrete and practical treatment of form in space provides skills in construction, calculation and measurement that support work in other areas such as art, design, architecture and technology.



Content Organiser

Mathematics 8.4 **Topic: Geometry and Measurement**

Students will learn to:

1. Apply the circle geometry theorems to proofs requiring sequential logic;
2. Investigate the symmetry, transformations, rotations and reflections of shapes through construction;
3. Investigate the similarity of shapes, and establish the conditions for congruence of triangles;
4. Apply the relevant formulae for the area of different triangles and circles, and the volume and surface areas of various solids;
5. Experience and develop an understanding of the content of this topic both with and without the use of digital technologies.

Content Elaboration

Learning Experiences	**Multi-modal and Artistic Activities**	**Conceptual Knowledge and Skills**
Students perform circle constructions as instructed by the teacher, and accurately measure angles, lengths etc.	Students could discover the circle theorems directly from the measurements that they have taken from their constructions.	Students develop the ability to apply axiomatic facts in a process of sequential logic.
Students could construct shapes such as parallelograms, trapeziums or compound shapes.	Students could investigate the symmetry, transformations, rotations and reflections of more complex or compound shapes by construction.	Students gain confidence in the power and mobility of their thought in visualising and manipulating shapes.
Students construct or model solids such as prisms, cones, cylinders etc, and calculate their volume and surface area from direct measurement.	Students collaboratively develop formulae for the calculation of areas, surface areas and volumes, and use them in problems.	Students appreciate the practical aspects of measurement and calculation as applied to two and three dimensional forms.

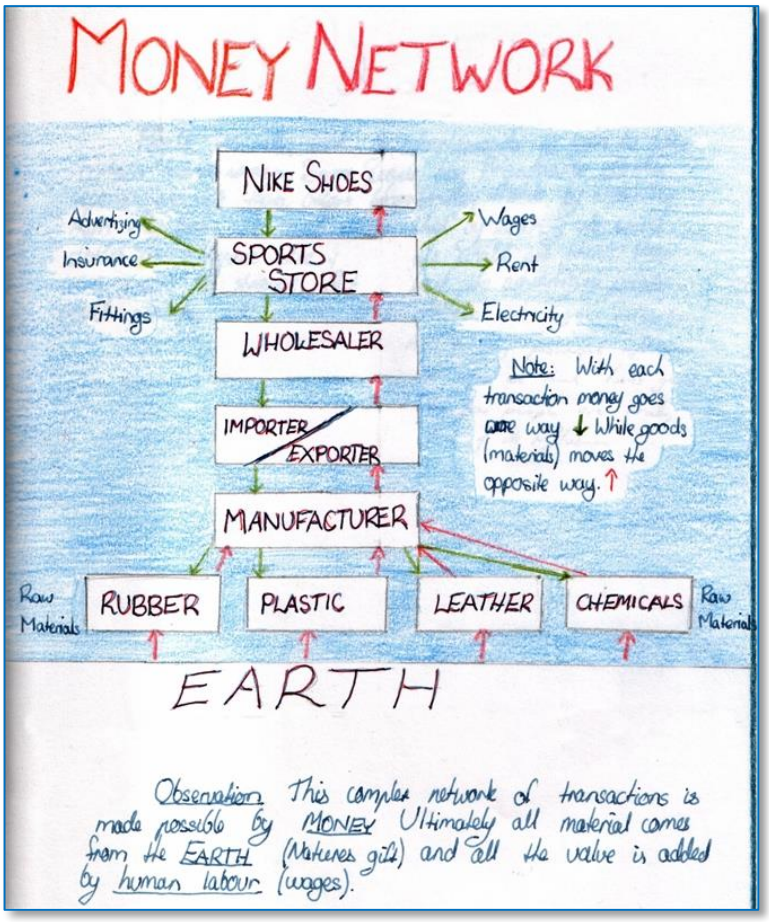
Mathematics 8.5 Money and Society

The Central Experience of the Content

This topic revises and applies the arithmetic skills learned in previous years while giving students a meaningful picture of the role of Mathematics in the world of finance. Students experience a picture of the historical development of human financial systems, and the role and function of money in a complex modern society. A picture is developed of how money functions as a token, and how value can be ascribed to goods, or added to them by human labour.

Future Capacities

The content of the lessons should empower students to feel at home in the modern world and lead them to bring all they have learnt into a meaningful world picture. This topic meets the students' interest in the outer world of business and finance, while giving them a deeper appreciation of the importance of money as a symbol of trust in our society which will contribute to their ability to make moral and ethical judgements in their dealings as adults.



Content Organiser

Mathematics 8.5 **Topic: Money and Society**

Students will learn to:

1. Understand and appreciate the historical development of our system of exchange based on money;
2. Record information and present it graphically;
3. Consolidate and extend their knowledge of percentages by performing calculations involving cost price marked up to selling price, profit and loss, discount etc.;
4. Perform calculations based on simple and compound interest, loans and investments, deposits, hire purchase etc.;
5. Perform calculations based on a range of systems on remuneration – retainer, commission, income tax etc;
6. Perform simple surveys and develop awareness of reporting on surveys in the media;
7. Experience and develop an understanding of the content of this topic both with and without the use of digital technologies.

Content Elaboration

Learning Experiences	**Multi-modal and Artistic Activities**	**Conceptual Knowledge and Skills**
Students propose their own system of exchanging goods and services within the class group.	Students could develop their own barter or exchange systems, research historical financial systems of trade and exchange, or hear teacher presented accounts of particular historical currencies and their development.	The students are brought to an appreciation of the historical development of our system of exchange based on money.
Students record and graph the exchange rate of AUD to USD together with the Gold price.	Students could investigate the fluctuations in value of other currencies or industrially significant commodities, record and graph the information, and present it in various ways.	Students develop an appreciation of the uncertainty of the economic future and the factors that affect it.
Students perform calculations based on transactions.	Students could revise and extend their knowledge of percentages by performing calculations involving cost price marked up to selling price, profit and loss, discount etc.	Students develop an understanding of the world of trade and business, of the realities of profit and loss etc.
Students perform calculations based on loans and investments.	Students could perform calculations based on simple and compound interest, loans and investments, deposits, hire purchase etc.	Students develop an understanding of the world of finance, of the realities of loans, credit etc.
Students perform calculations based on remuneration.	Students could perform calculations based on a range of systems on remuneration – retainer, commission, income tax etc.	Students develop an understanding of the practicalities of different types of remuneration for labour or services, of the realities of taxation etc.

Achievement Standard Year 8

1. By the end of Year 8, students are familiar with expressing very large and very small numbers in scientific notation. They review and extend their previous work with index notation and laws, and investigate irrational numbers such as π. Students extend their experience of problems involving speed, distance and time to include other rates, and solve them both with and without digital technologies. They encounter very small and very large numbers in the context of distance and time.

2. Students consolidate and extend their previous experience of practical problems involving the use of percentages to the solution of problems involving compound interest, loans, investments, deposits and hire purchase. Problems are also encountered that are based on a range of systems of remuneration. Students approach and solve these problems with and without digital technologies.

3. The student applies the associative, commutative and distributive laws to increasingly complex algebraic expressions, and factorises them by seeking a common factor, and by the difference of two squares. The study of indices is extended and applied to the solution of algebraic expressions arising out of practical problems, including surface areas and volumes.

4. Students revise the various methods of plotting linear relations on the Cartesian plane and introduce digital technologies to the solution, both graphically and algebraically, of simple linear equations. They investigate the relationship between the algebraic and graphical representation of rate problems.

5. Students extend their previous work on area and perimeter to include surface areas and volumes of prisms, cones, cylinders and composite forms. They discover and investigate the relationship between the features of a circle such as radius, diameter, circumference and area.

6. Students construct polygons, measure their sides and angles, become familiar with theorems relating to them, form patterns by tessellation, and discover the Platonic Solids and Euler's formula. They represent these forms both with and without digital technologies. Students investigate the metamorphosis of form through the concepts of ratio and proportion, scale, symmetry, and the transformations of linear relations and more complex compound shapes.

7. Students solve problems based on quadrilaterals, circle theorems and congruence, and encounter more complex problems based on Pythagoras' theorem.

8. Students perform simple surveys and probability experiments, and investigate different ways of representing data. They choose appropriate language to describe events and experiments, and calculate the sum of probabilities. They explain issues related to the collection of data. They calculate mean, mode, median and range for data sets.

9. They deepen their understanding of the world of business and finance, and investigate the visual means of presenting data in the media, such as financial information and share prices in the newspaper.

General Capabilities

Literacy

Students are able to integrate the development of literacy skills throughout the mathematical topics in year 8. In Mathematics they continually develop and extend their ability to present information in the form of tables, graphs and visual texts. Students encounter more text-based statements of mathematical problems, and topics such as 8.1, 8.2 and 8.5 allow for the possibility of students generating research projects and written presentations.

Numeracy

In year 8, students increasingly recognise and understand the role of Mathematics in both their personal lives and the world around them. They are presented with many opportunities to develop confidence in their ability to describe, represent and solve problems, and apply mathematical thinking to other learning areas.

Information and communication technology (ICT) competence

In year 8, the students are exposed to digital technologies in their study of Mathematics. They learn to use ICT appropriately and effectively in the representation and solution of problems. Digital technologies can engage students and allow for deeper understanding of mathematical concepts, but the primary focus remains on the development of robust thinking and problem solving skills, which can then be applied to the students' work with ICT.

ICT can be used in all topics in year 8, but is particularly useful in the constructions of tables and graphs, the representation and transformation of compound forms and the Platonic Solids, dealing with repetitive calculations such as interest on loans and investments, or the representation of the fluctuations in share prices and exchange rates etc.

Critical and creative thinking

Students in year 8 sharpen their powers of critical thinking as the faculties of intellectual thought continue to awaken within them. They increasingly experiment with the mobility of their thinking to define and deal with scenarios and problems encountered in the mathematical topics. The consideration and development of solution strategies to a variety of problems requires the students to exercise reason and is indicative of their increasing development of a sense of discernment. The topics provide students with the opportunities to form their own judgements about experiences they have gained from the lessons.

All the topics are imbued with a creative element that encourages the students to look at mathematics from a variety of perspectives. Creative thinking skills are encouraged as a means of developing original or alternative approaches to problem statement and solution. Geometry is appreciated both as an accurate visual and artistic representation of form, and as a means of discovering the properties of shapes.

Ethical behaviour

At this age students increasingly identify and articulate their individual moral stance to personal, family, school and world issues. There are many opportunities in Mathematics to engage with and develop values, ethical principles and moral integrity.

Personal and social competence

Students are well and truly immersed in the experience of adolescence. Their social relationships and immediate peer group continue to be priorities for them as they learn and experiment with managing themselves, their relationships and their school life. Topics in Mathematics are investigated both individually and in group contexts. Students develop the ability to work both independently and co-operatively in teams, thereby nurturing positive social interactions. Mathematics continues to be presented as a quintessentially human endeavour that is intrinsic to the history, culture and development of the human being.

Intercultural understanding

Students appreciate that the evolution of Mathematics has taken place within the context of the development of human culture over the course of several different epochs of history. They are presented with the biographies and contributions of Mathematicians from cultures as diverse as the classical Greek

and Mediterranean civilizations, Persian and Middle East cultures, Egyptian, Arabic and Islamic cultures, as well as European, Asian, African and Aboriginal and Torres Strait Islander cultures. Students learn to appreciate and respect the cultural differences between people and build a capacity for imaginative empathy, which is understood to provide a firm foundation for moral conscience, ecological awareness and global citizenship.

Opportunities arise within all the topics in year 8 to expose students to the mathematical thinking and contributions of other cultures.

Links to Other Learning Areas

In general the close interrelationship of subject areas in ASCF strengthens the crossover of the foundational skills students develop in Mathematics.

The Mathematics topics are aligned to other subject areas such as the link with Science, History, Art and English in topic 8.1; Art, Science, History, and Eurythmy in topic 8.2; Science and English in topic 8.3; Art and Science in topic 8.4; History and English in topic 8.5.

Cross-Curriculum Priorities

Histories and cultures of Aboriginal and Torres Strait Island peoples

It is possible for content selection for many of the topics in year 8 to include material from Aboriginal and Torres Strait Islander histories and culture. In topic 8.1, students could investigate Aboriginal and Torres Strait Islander concepts of Astronomy, and their measurement and representation of time. In topic 8.4, students could investigate geometric patterns employed by Aboriginal and Torres Strait Islander cultures in their art. In topic 8.5, students could investigate the methods employed by Aboriginal and Torres Strait Islander cultures to manage trade and transactions.

Asia and Australia's engagement with Asia

It is possible for content selection for all the topics mentioned above to include material from Asian history and culture, in similar ways to the integration of Aboriginal and Torres Strait Islander histories and culture.

Sustainability

Students are exposed to scenarios, problems and situations in which they have the opportunity to consider ways in which more sustainable patterns of living can be developed. Mathematics provides understanding and skills that contribute to the evaluation, quantification and interpretation of information relating to social and environmental problems. Topics 8.1 and 8.5 are particularly suited to offer opportunities for investigating issues relating to sustainability.