Steiner Education Australia

AUSTRALIAN STEINER CURRICULUM FRAMEWORK 2011

MATHEMATICS INTRODUCTION

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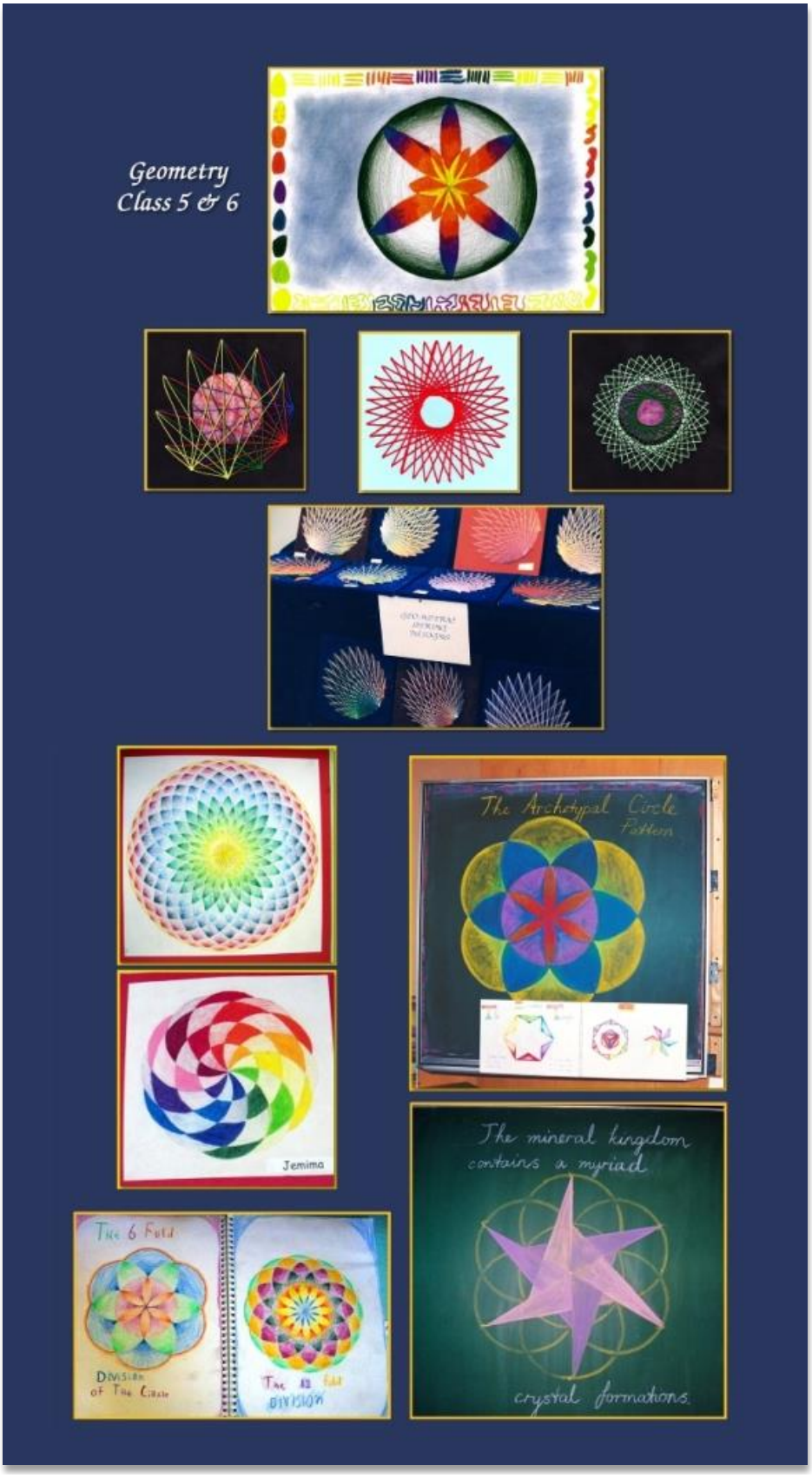
Geometry
Class 5 & 6
The Archetypal Circle
Pattern
Jemima
The mineral kingdom
contains a myriad
crystal formations

Australian Steiner Curriculum Framework
MATHEMATICS
General Introduction

"All the secrets of nature are written down in that magnificent book which is continuously before our eyes. I refer to the universe. But we cannot understand it if we do not first learn the language and letters in which it is written. It is written in the language of mathematics and the letters are triangles, circles and other geometrical figures, without which we should find it impossible to understand a single word." Galileo 1546-1624AD

1. INTRODUCTION

This Mathematics Curriculum Framework is based on the extensive indications given by Rudolf Steiner and curriculum resource materials developed by teachers in Steiner schools both in Australia and Internationally. It is being prepared in collaboration with Steiner Schools in Australia through a process of consultation with Learning Area Consultants and the Advisory Panel as well as opportunities for individual school and teacher response. This Curriculum Learning Area should be read in conjunction with the Educational Foundations and Academic Alignment Paper, the Position Papers on Kindergarten, Primary (Stage 1 and 2) as well as High School (Stage 3 and 4).
This Mathematics Curriculum is designed to be used by both new and experienced teachers to support and supplement their research, planning, teaching and assessment. It is informed by International and Australian Steiner Education Research and Curriculum Publications as well as broader recent research in Mathematics education.

2. RATIONALE

Mathematics, at the concrete level of life skills, will allow students to participate fully and meaningfully in our world in practical family and community life and in the realm of personal business and finances. Mathematical processes, skills and understandings also form a basis of professional expertise in many vocational tasks.

Mathematics examines patterns and relationships in quantities, space and time as experienced in the natural world from the infinitesimal to the movements of the heavenly bodies in space. The curriculum seeks to embody the sense of wonder and beauty that can be experienced in engaging with the world around us. Mathematics helps us to build a relationship to the world, to find meaning and engage in a dialogue with it. It encourages enjoyment in this discovery and exploration.

Through Mathematics at the higher levels students will be enabled to take what we perceive of the world through our senses and use language, process and thought to describe our experience of the form, spatial relationships and metamorphoses of the world as they unfold through the passage of time. In enriching and organising these thoughts we approach the formative principles that underlie the dynamic structure and constant growth and change of the natural world.

What the eye is to physical perception, the enlivened thinking can become to the perception of these archetypal formative principles.

The development of this faculty of penetrative thought can be a deeply meaningful and inspiring process for the human being. Students can use the study of Mathematics to nourish, develop and hone their thinking life: as a whet stone for the intellect.

Mathematics can also be an education which allows students to experience truth in simple number realities and shapes. At a later age it can be used it to test the truth of predictions about the phenomena of science. Being able to test their thoughts in the concrete world can be a necessary first step in developing the judgement or discernment to work with integrity with more complex or deep thoughts in the world of ideas.

Mathematical thinking is a striving to experience what presents itself to us externally in an inwardly exact manner. This then frees us to be able to make our own decisions rather than relying on the prescriptions of external authority, and to make informed contributions to our local and global environment.

The development of flexibility, creativity and imagination in problem solving invests students with the ability to devise original and innovative approaches to current and anticipated problems. This allows for a dynamic process of growth in their collective knowledge base about our inner and outer worlds.

Mathematics is a distinctly human endeavour that is both a rigorous and coherent discipline and an engaging, worthwhile activity in and of itself. It is a social phenomenon, an international symbology, a language which transcends linguistic, cultural and geographical boundaries.

Futures Education
In the future lying before us with its complexity, challenge and rapid change, these higher faculties of thought will be necessary to maintain individual connectedness to the world, find new meaning and bring transformation. Mathematics can find concepts and forms for evermore complex and subtle elements of the world.

Mathematics can bring recognition of the beauty of form and therefore inspiration to our world as the essence of phenomena is experienced. Seeing the natural forms and growth structures of nature can bring a deeper connection that transforms our relationship to resources and the environment.

Mathematics allows the building of creative thinking skills, problem solving and integration of disciplines. The teacher as mathematician can embody the pathway to independent free thought.

Mathematics can empower students to develop our values, personal and interpersonal skills as we undertake to make sense of and responsibly harness our rapidly evolving technological landscape.

AIMS OF THE STEINER MATHEMATICS CURRICULUM

- To develop the mathematical skills for daily life in family and community.
- To prepare students for the vocational landscape with its increasingly technical and scientific approach through developing the mathematical skills that can be applied to any area of further study.
- To enhance the capacity of mathematical and creative thinking and develop confidence in the reliability and accuracy of the students' own thought processes and problem solving abilities.
- To develop the students' skills of discernment and so prepare them to make informed and ethical decisions about issues which involve mathematical knowledge in finance and business.
- To connect the students to the historical stream of human endeavour in mathematics and the process of growth in culture.
- To develop a high level of fluency in computational skills before any extension into the technological realm.
- To sense, imagine and value the beauty of mathematical form within the natural, artistic and built environment and experience the joy of mathematical discoveries, processes and thinking.
- To use insight in mathematical thought to examine and reflect on human social, scientific, philosophical or ethical dilemmas.

ORGANISATION

Content Strand Descriptors

The content of curriculum can be viewed historically through the seven liberal arts. The first four are mathematically related- Arithmetic, Geometry, Music and Astronomy. Arithmetic and Measurement differ in that number can be imagined in the pure world of thought while measurement has a connection to the concrete world. Music is number in movement and number intervals in harmonious combinations. Astronomy looks at the geometry of cosmic movement. Statistics and probability come from a later paradigm of engagement with the world which seeks to quantify events and predict outcomes.

The Australian Steiner Curriculum Framework: Mathematics is organised around the interaction of three content strands and six proficiency strands.

The content strands are Number and Algebra, Statistics and Probability and Measurement and Geometry.

Number and Algebra – This strand focuses on development of a qualitative and quantitative sense of number. It includes sequential and rhythmic number patterns and intervals and balance in number which has been separated from the whole into various combinations of its parts (algebra). It extends to the description and modelling of practical situations or natural phenomena in ways that are simple, powerful and elegant.

Measurement and Geometry - This strand finds its reflection in the natural, built, artistic and cosmic world. Geometry involves the study and appreciation of both static and dynamic forms. This includes, but also transcends the measurements and calculations that can arise from geometric forms. In the Australian Steiner Mathematics Curriculum this also includes the transformations of forms, descriptive geometry, projective geometry, polar coordinates and morphology. Geometry draws upon, supports and deepens the cultivation of imaginative and aesthetic faculties.

Statistics and Probability

Although the collection and interpretation of information or data happens informally and largely through individual or group based play in the earlier years, it is nonetheless a rigorous embodied experience of mathematical concepts. This then progressively develops through the ordering, manipulation and representation of data to extend the description and understanding of a situation, which allows for informed judgement and decision making.

Proficiency Strands

Exploration

Students develop a capacity for embodied creative exploration in the early years which transforms to a retention of the faculty of wonder and inner exploration in later years. Faculties of innovative, imaginative and creative thinking develop and flower to create possibilities for innovation and entrepreneurial approaches.

Knowledge and Understanding

Students develop knowledge and understanding which supports the ability to imagine the forms and transformations of mathematical ideas. The archetype of each numerical concept, process or form is encountered. Their mathematical thoughts are mobile and dynamic, being capable of adaptation and transfer. Students are able to make connections between them and develop new ideas.

Fluency

Students build skills in developing, creating and choosing appropriate procedures and carrying these out flexibly, creatively, accurately, efficiently and appropriately. They can recall and recreate the knowledge and concepts behind their mathematical processes readily through thought, body awareness, sensing and imagining.

Problem Solving

Students develop the ability and confidence to describe the question, imagine the solution and see the potential for change in problem situations. They can make choices, interpret, formulate, model and investigate individually and also in creative collaboration. They develop the capacity for communication through visual, verbal, written, artistic and digital modalities.

Reasoning

Students encounter visual, auditory and kinaesthetic experiences which translate into capacities for creative and imaginative thought. As well as the capacities of logical thought (analysing, proving, evaluating, explaining, inferring, justifying and generalising) they develop divergent thinking. They have the ability to synthesise organic thought and perceptions. They have clarity in the realm of pure concept or idea.

Imagination / Sensing Formative Patterns

Students develop the ability to sense the qualities of form, pattern and metamorphosis in the natural world in the form of resonance. They can experience and make conscious the underlying principles or forces with their imagination and mobility of thought and so experience this resonance also in the world of ideas. They can synthesise organic thought and perceptions into a harmonious unity of ideas.

STAGES OF MATHEMATICS EDUCATION

Stage One - K- 3
Stage Two – 4 -6
Stage Three – 7-8
Stage Four – 9-10
Stage Five - 11-12

Stage 1: K- 3

Mathematics takes the young child out of the real world into ideas and thus initially it is exploration and play that weave the two together. Child-directed play forms a first exploration into mathematics. Balance, form, sorting, classifying, one to one correspondence, symmetry and ordering are all actively experienced.

Mathematics has a relationship to the human senses of movement and balance. With movement we follow mathematical patterns in numbers eg from the simple movement of the sequence of counting to the complexities of infinite series. We also use movement of the inner eye to experience the spiral or even a simple square.

Balance is necessary to perceive the equality of the simple algorithm and to work with solving algebraic equations. Both balance and movement need to be experienced in the physical body first and developed to a skilful proficiency as a basis for later mathematical processes.

The relationship of number and rhythm and movement requires a curriculum which is based in the primary years in rhythmic body work in counting, sequencing, number facts and tables. Integration in the curriculum of diverse artistic modalities such as speech, movement, visual image, narrative and dramatisation allows the strongest imprinting.

Narrative strengthens the imagination and through the character and movement of images in the story the picture representations embody number and process realities as well as strategies.

Number processes, strategies and written algorithms are all built on this experiential and rhythmic base from Class 1 upward.
The play-based mathematics of Kindergarten becomes guided exploration in Class 1-3. The four processes are introduced in Class 1, consolidated in Class 2 which also sees the introduction of Vertical algorithms and in Class 3 measurement work is active and exploratory as well as involving computation. Music is another mathematical experience in the timing, pitch and harmony.

Stage 2 - Class 4 – 6

The rhythmic work continues as the number facts are consolidated. Form Drawing continues but is extended now in Geometry Topics in which skill develops; first freehand and then with instruments. The triangles and quadrilaterals are derived and then further polygons are constructed out of the divisions of the circle. In Class 4 work with Factors and Multiples is developed and then Fractions are introduced and the four processes applied in concrete problems. In Class 5 this moves on to Decimals and in Class 6 to Percentages, Interest and Business Mathematics. Strategies are further developed and Long Multiplication and Long Division are introduced and practiced in this context. Mathematical thinking becomes ever more individualised while narrative still provides images of increasingly complex mathematical ideas. The history of mathematics in Class 5 and 6 Topics on Ancient Cultures provides understanding of how our consciousness and world view shapes our mathematical challenges and discoveries.

The later years foster the beginnings of individual creativity of thought in the application of the basic skills. Causal thinking begins to develop towards the end of this stage.

Stage 3 - Class 7-8 , Stage 4 Years 9-10

Mathematical thinking becomes strengthened and energised, and more focus shifts to the development of formal logical thought. The thinking is strengthened by being applied to practical situations.

At a time where adolescence brings a multitude of inner transformations, the security of timeless and concrete Mathematical laws develops confidence in the thinking, which in turn translates to increased self confidence. This fosters inner development and self knowledge.

The aesthetic beauty and form of Geometry in the earlier years is augmented by a new understanding of the rigour of the Geometric laws, rules and proofs. This is carefully balanced with a fluidity and dynamism to maintain and encourage mobility of thought.

Deductive reasoning is developed by an increasing introduction of multistage processes and sequential logic over the course of the stage. Relationships between the Mathematical disciplines are introduced by linking previously separate areas of the subject.

Years 11-12

The boundaries of the sense perceptible are challenged by moving beyond what is able to be directly grasped into a deeper abstraction of concepts. Calculus descends into the infinitesimal, while Projective Geometry extends to the infinite. The power of imagination and the ability to visualise and manipulate Mathematical ideas is tested and strengthened.

There is a synthesis of Mathematical knowledge across the content strands where previously encountered solution strategies and processes are considered to allow for diverse, creative and individual approaches to problem conception and solution. Innovation in the approach to unseen or unfamiliar contexts is encouraged to inspire original and entrepreneurial thought.

Links are established between Mathematics and other disciplines such as the Sciences and Arts, and the contributions brought about by viewing these disciplines through a Mathematical lens are evaluated and incorporated into a richer, more holistic picture. The appreciation of Mathematics as a descriptive and analytical tool is developed while also acknowledging its contribution to our qualitative understanding of the world.

The static forms of Euclidean Geometry are transcended by the dynamic power of Projective Geometry, which extends and nourishes the ability to use thinking as a tool to grasp archetypal and universal phenomena.