Steiner Education Australia

AUSTRALIAN STEINER CURRICULUM FRAMEWORK 2011

SCIENCE INTRODUCTION

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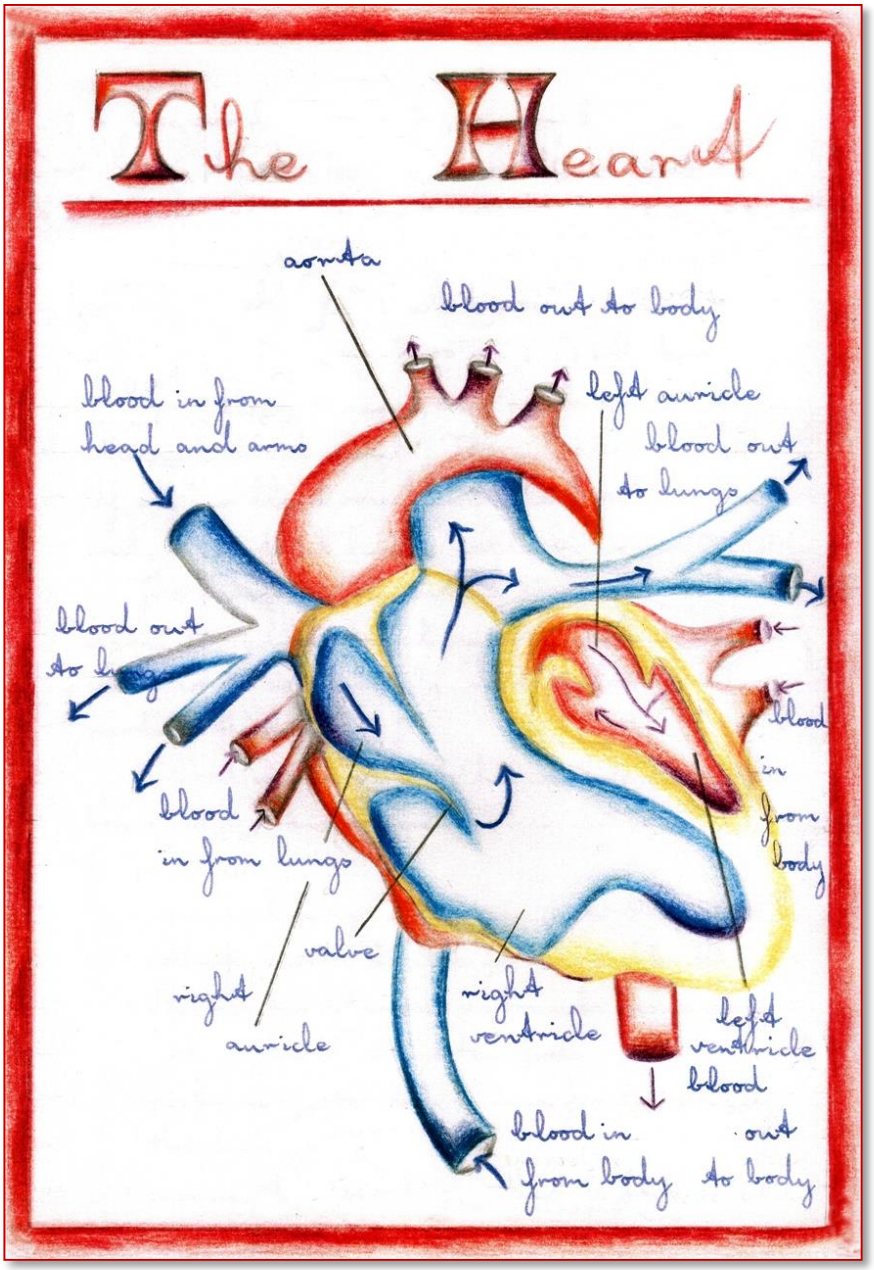
The Heart
aorta
blood out to body
blood in from head and arms
left auricle
blood out to lungs
blood out to lungs
blood in from lungs
blood in from body
valve
right auricle
right ventricle
left ventricle
blood out to body
blood in from body

Australian Steiner Curriculum Framework
SCIENCE
General Introduction

Australian Steiner Curriculum Framework: Science

Rationale

1. 1 Relationship to the Contemporary World

Science as a human endeavour is a way of increasing our understanding of what enters the field of our experience. This can include the kingdoms of nature, ourselves, society, history etc. The scientific attitude is one of independent thinking based on one's own experience or the experience, sometimes, of others. Natural science is this attitude of science extended to the kingdoms of nature.
It has had a significant influence on three areas of modern life, since at least Renaissance times. They are:

- Our technological environment, and synonymously our natural as well as social environment;
- Our cultural development in the way it helps shape our conception of the world;
- Our individual development in the way it has helped shape an increasingly independent, relationship to the world. This is twofold. Firstly sciences have played an enormous role, in enabling human individuality to emancipate itself from old forms of authority (exemplified in the lives of Giordano Bruno, Galileo and others) and base its action on the discipline of observation, reflection and a testing methodology as a basis for coming to decisions for action. Secondly, it has had a role in our learning about the world – its beauty, inner consistency and interrelationship with humanity – a basis for loving the world.

The way that science has shaped individual relationship to the world indicates the three elements of science:

- The spirit of investigation and enquiry which encompasses curiosity, wonder, objectivity, learning to use evidence etc. i.e. science methodology;
- Objects of investigation e.g. plants, animals, rocks, landscapes, human beings, stars, oceans, theories, ideas etc. i.e. science content.
- The way that individual human biographies have applied the spirit of enquiry to objects of investigation to achieve breakthroughs in understanding – human endeavour.

The curriculum, therefore, needs to take into account each of these areas in the context of the developmental stages of the student. This integration of subject content and methodology with child development is a key element of teaching in a Steiner school. As the three influences unfold in time, building a natural science curriculum demands knowledge of the History of Science, Human Development, Theory of Knowledge and practical experience in teaching. As well, science will need to be integrated with and address overall educational aims. These aims are about the student's relationship to self, place and time. Under these headings all the characteristics of a futures-oriented curriculum can be included (care of the environment, global citizenship, search for meaning, balancing interaction of technology with the natural world).

1.2 Science in the School Curriculum

Encouraging and modelling **the spirit of investigation and enquiry** provides a way that the growing child approaches new experiences in an open, explorative way. The methodology of teaching, which varies from stage to stage in a Steiner school, is characterised by the valuing of the experience of the student and the employment of that experience in the step of age-appropriate understanding. This openness to new experience is a character quality that accompanies a person through out life and contributes positively to personal, vocational and social skill.

Understanding the kingdoms of nature and the place of the human being within them as **science content** encourages a sustainable view of life and also tolerance. In the Steiner educational approach, all content is related to the human being so that students feel engaged and connected to the world in which they

live, as well as to themselves. The topics within a subject are chosen in an age appropriate way that reflects the physical, emotional and intellectual readiness of the student. The topics also reflect the way that the history of science has evolved from embedded nature awareness to an awareness gained through more abstract intellectual principles.

Human endeavour is highlighted in the teaching of science so that students can identify with the topic out of a connection to human biography. Even the teaching of complex principles is connected to the human being who, often from humble beginnings, has striven to achieve the heights of understanding attained in scientific investigation. Such a way of teaching includes all students in the appreciation of complex ideas.

1.3 Connection to the Melbourne Goals of Successful Learners, Confident Creative Individuals and Active Informed Citizens

1.3a **Successful Learners**

Th methodology of teaching science , integrated with the arts and the humanities as well as based on the experiential, philosophical mode of teaching science in Steiner schools, develops a culture of learning how to learn. Bill Wood (2006) studied 179 students who had graduated from the Mt Barker Waldorf School, SA between 1991-2001 of whom 78 had gone to university. It was clear that the ex-MBWS students had performed very well at university. (Wood, 2006, Table 7, p. 265) and on the basis of his empirical comparison he was able to demonstrate that ex-MBWS students as a whole perform significantly better than a sample of non-MBWS students at the University of Adelaide, based on results by grade (Wood,2006, Table 10, p. 275). He argues that the success of ex-MBWS students at university may be attributed to their successful performance in the secondary curriculum (content and methods) of the MBWS which is radically different from all other curricula, particularly in the science teaching.

The educational results of pupils who have attended Steiner Schools in Germany are also impressive. This is already reflected in the fact that in 1990 almost twice as many pupils of Rudolf Steiner schools (57.5%) attained the qualification necessary for university studies than pupils of the same year attending state schools; and this despite the fact that their work had not been sanctioned for twelve years by marks (Ullrich, 2000).

1.3b **Confident Creative Individuals**

An earlier quantitative survey of former German pupils of the Rudolf Steiner schools (born in the year 1940/41) revealed significant differences between this group and a control group in the following areas: higher geographical and social mobility; more pronounced leisure activities in the areas of reading, interest in art, practice of a musical instrument and ability in craftwork; and an interest in further training.(Ullrich, 2000) A recent qualitative study of the educational biographies of former pupils of a Rudolf Steiner school with a double academic and professional curriculum (Hibernia School at Herm, Germany) also showed that these pupils were better equipped to face the challenge of life and, in particular, more capable of dealing with technical tasks. They showed greater self-confidence and a wider range of interests, were open to new ideas and were particularly willing to accept social responsibility (Ullrich, 2000).

Gidley (1998) reports research which investigated the views and visions of the future of Steiner educated senior secondary students using quantitative and qualitative methods. The students demonstrated a strong sense of activism and self-confidence and felt empowered to create their own preferred futures. This capability is referred to as 'prospectivity' of futures visions. In exploring the human qualities they thought they should develop to contribute to their ideal world in 2020, the students identified such factors as more activism, more awareness, attitude and values changes, future care and more spirituality.

1.3 c **Active Informed Citizens**

Because of the way that science is taught in a contextualised and integrated way, students tend to grasp the relevance of the ideas for a social context. The mode of teaching is experiential and philosophical which encourages students to think about scientific ideas and discuss them in relation to modern global situations and problems.

Aims

- Create a sense of wonder, both for the world and its environments and for the creative place of the human being within this world.
- To use the content of the evolution of scientific thought and discovery as a training of individual powers of judgement and discernment. To see Science as a pursuit of truth in all fields of experience.
- To enable the students, to understand more fully the natural and technological processes of which they are a part, so that they can participate more fully and responsibly in life and society
- To provide opportunities for students to gain practical skills in the use and operation of significant areas of science and technology.

ORGANISATION

Strands

Science Enquiry develops through the stages from play based explorations to phenomenological observations and then to recognition of forms, patterns, metamorphoses, and laws, to further investigation and experimentation and then to formulation of personal, social, ethical and spiritual questions and quests.

Science as Human Endeavour moves from the teacher as the concrete picture of the scientist in the young child's life to the history of science in ancient cultures and then to biographies of scientists before the philosophical and ethical questions of science in society re taken up by the young person themselves as scientist.

Science as Understanding grows through stages of embodied knowledge in play to pictorial understanding through narrative; then recognition of form and metamorphosis in observation; to development of descriptive theory and then to critical reflection of current scientific paradigms.

Curriculum aligned with optimal learning for each stage

Science is lived in the young child before it is felt and felt in the student before it is known. Children are by nature one with their early experiences and observations. The challenge is to maintain the possibility of a connected perception while abstract thinking evolves. Vivid pictorial thinking which takes hold of reality while reflecting on it builds a capacity for the imaginative and intuitive insight of human endeavour.

Stages of Science Education

Stage 1 K- Class 3

Children in Kindergarten experience natural phenomena through their sense impressions. They have deeply embedded experiences of the forces, forms and life of the world e.g. When they swing on a rope they have an experience of a pendulum, gravity, air currents and the cantilever. The laws that are named later are experienced first - e.g. gravity. If not experienced first as an embodied experience then it could remain a theory later. This is a pre-scientific age but it is a pre-requisite for science.
Experiencing touch, balance, life and movement – the 4 lower senses – is essential at this age. Therefore a conscious created environment and conscious rhythm is needed as well as other children to imitate.

Young children's curiosity and desire to play and explore is the basis of science at this age. Exploratory play in natural environments and with unstructured materials allows the child to create, build, carve, dig, order, mould, hide, transform, structure, pull down or bring into relationship the concrete world and experience form, weight, balance, beauty and movement. They use their senses to open themselves to unimpeded experience of becoming one with the forces and creatures around them.

During Kindergarten and Classes 1-2, the young child is protected from being taken out of the experience.
Narratives of the world of the sun, moon and stars, stones, flowers and trees and animals with truthful pictorial imaging help order the sense impressions from the world and bring connection between them.

The teacher's vivid pictorial descriptions highlight or reveal details less easily perceptible and the child's consciousness is directed in a new way to this realm of the world.

In Class 3, as the children begin to feel separated from the world, they are brought toward practical experience and connection to practical life around them. They meet Topics such as Farming and Building in which they experience the confidence that results from developing their own vegetable garden, growing grains, making mud bricks, building a structure in the school grounds and churning butter and grinding the grains. They become connected to the earth in an empowered way as well as forming a class community working cooperatively.

Stage 2 Classes 4- 6

As the child separates in identity from the world – moves from the animism of the early years – then stories of nature become more characterisations than imagination-filled pictures and dialogues.
The human being is the starting point of the second stage- in a descriptive/ pictorial content of the form and capacities including uprightness, speech and thought. In the animal world students recognise how form and structure relate to function (Class 4), then in the plant world the relationship to the earth, the sun, water and air are studied (Class 5) and finally the mineral realm (Class 6) and the rocks in relation to the landscape and depending on place, volcanic action, mountain building and earthquakes are brought. The transformation of living matter over time into the dead mineral realm and geological formations helps create a relationship to the rocks as underlying the landscape. The human beings responsibility for farming and development emerges. Awe and wonder for the celestial sky with detailed observations of the movement of the sun, moon planets and constellations begins Astronomy.
The Astronomy can be brought into relationship to World Geography- through links between climatic conditions, plant growth and astronomical conditions. These links are brought in a pictorial way, still through the association of qualities rather than in a cause and effect relationship which can be followed more easily when the students are older.
The development is also from narrative built on characterisation to phenomenological observation on the part of the student of both natural phenomena and experimental sequences.
In class 6 students discern between perceptions- e.g. types of brightness in the image world. This is where formal science teaching begins in the Steiner /Waldorf School. Of course teaching towards science, in the early years takes place but more like an artist with a fine brush. In class 6 the activity of judgement begins in a preliminary way in the **arrangement of sense perceptions**.

Stage 3 Years 7-8

Year 7– beginning of **taking perception into the causative realm** i.e. from pitch related to vibration – mechanics it is still embedded in pictures or riddles to solve e.g. lever, pulley. The students though still largely pre adolescent are eager to exercise their independent judgement in causal situations. The introduction of the understanding of simple machines coincides with a **causal judgement of oversee able phenomena,** such as the connection of tone and frequency in acoustics or the gearing ratios on a bicycle. This is the last chance to do human biology and hygiene before the students have a more self centred relationship to the study.

Year 8- students **meet practical judgement** about more complex situations such as the telegraph and the movement of sound waves through the air.
In Class 8, the students are14 years and have hit adolescence. They are often awkward in their own bodies and have sometimes lost the gracefulness of childhood. Clumsiness and a new vulnerable awareness of their feeling and thought life are some of the ways we could characterise the adolescent. They are not naturally philosophical and it is not the age to question science and technology, but to learn to understand those parts of it that are accessible. It is the age of scientific positivism. Lessons should be accompanied by inspiring biographies and phenomena that are oversee able. The content of the lessons should empower them to feel at home in the modern world and to realise that much of it is understandable, that human beings have created much of it and that ultimately they feel a real sense that they too will be able to be creative in this world. The level of judgement exercised is a more practical, mechanical judgement.. Idealism is touched upon by the narration of the biographies of great human beings as much as possible.

Stage 4 Years 9-10

Year 9 involves **aesthetic judgement**. In Class 9 the students are turning 15. Their powers of intellect are growing and their physical bodies are generally becoming muscular and the bones are becoming heavier. Different abilities are becoming more pronounced between boys and girls. Generally the girls are freer in their social, verbal expression whereas the boys tend to be growing in physical strength and they are still less elegant socially. More can be asked of their power of judgement, although it is best still that they are asked to use their discernment in the field of **practical judgement** e.g. how things that are oversee able work. The telephone and the combustion engine provide excellent and socially far-reaching examples from modern life (transport and communication) to learn about and understand. **Added to the practical judgement is added aesthetic judgement** which is most evident in the newly introduced aesthetics lessons. The 15 year old stands at the edge of a looming, precipitous stage of life, which has both the qualities of excitement and danger and also responsibility for oneself and for the world. This last sense is one of those imponderable areas, which live in the unconscious life of the young person and can be tapped by the questions which touch the moral life but which are embedded in the practical understanding of the world. An example of this is the study of alcohol in chemistry below. There is so much that can be learned to satisfy the curiosity of the young person which at the same time can touch upon moral questions in a free way.
The students are not yet philosophical- but need ideals. Biographies become important. Thinking is more free and with more complex ideas.

Year 10 **-** formal **judgement** – e.g. surveying and mechanics/kinematics – this involves **precise predictability** and learning to trust thoughts e.g. drop a stone in a well and students can know how deep it is by counting the time taken to hit the bottom.
The Class 10 students are turning 16 yrs. They are in the height of adolescence in all its polarities, the best and the worst. It is an age where the young people can become lost in their own problems and emotional life. They are also capable of great feats of compassion, endurance, intellectual and physical prowess.
The intellectual and emotional and physical life needs to be challenged to draw it out into the greatness of the wide world and away from the seemingly smallness of individual existence. In fact the 'seeming smallness' of individual existence can begin to experience its 'large potential' by finding within itself the greatness of the world. In the natural science curriculum this can be brought out by demanding now a level of judgement that is more theoretical, where general laws with predictive power can be appreciated and applied in the world. The content of the curriculum for the 16 yr old has a degree of intellectual challenge which demands the students understand the laws of the world in a way that they are able to live into and predict phenomena. Mechanics offers this with predicting projectile and pendulum movement. Ideas such as: things in free fall really become weightless- weight is changing- distinguish between mass and weight.

Stage 5 Years 11-12

Year 11 - **abstract judgement** develops e.g. the idea of infinity, the journey of the self, or the question: what is an element? It is still based on experiences.
The class 11 students are turning 17 years old. It is often a turning point in adolescence when the young person has begun to become more aware of the rest of the world around them. The urgency and preoccupation with the 'self' has receded somewhat and a new openness for the other arises. With it come searching, penetrating questions, which are a prerequisite for philosophical thought. There is openness for a more subtle way of understanding the world and for understanding one's place in it. The level of judgement is one that is more abstract and analytical on the one hand and can ask for a deeper level of responsibility in relation to oneself. Year 11 is the year of 'Parsifal', which poses existential questions about one's own path in life. (See English Curriculum document). This step is important for the way in which Natural Science is pursued. This should become evident in the descriptions of the subjects below. An essential aim is expressed in the modern electricity main lesson where the thinking is extended from phenomena from the localised electric and magnetic effects studied in earlier years, to those needed to encompass the idea of a field, or action at a distance.

Year 12 - **philosophical judgement**- considering the origins of the human being and the cosmos or studying artificial intelligence.
Year 12 is the time where philosophical judgement is demanded of the students. Any questions, thrown up by the times we live in that question the human condition, are suitable themes for this age. They need to learn the capability of taking in information about a topic with openness and wonder, to grapple with it to understand the issues that it brings up and then to explore the questions that it raises with an inner confidence that the answers can be found by deepening of knowledge and also inner experience. The students can then realise that judgements are dangerous things to let fall too easily. They need to be explored from many sides, from many levels of experience before one forms a judgement about a topic.
For example: What are our origins? The course aims to introduce a broad base for ways of approaching that question out of the fullness of human experience rather than from a narrow thought paradigm. In this way it hopes to allow the students to experience that there are many questions that need to remain open and slowly answered out of the fullness of learning and life experience.

Ref (Stockmeyer 1955, Mitchell 1995, Mackensen 1995, Australian Steiner Schools Curriculum Documents,)