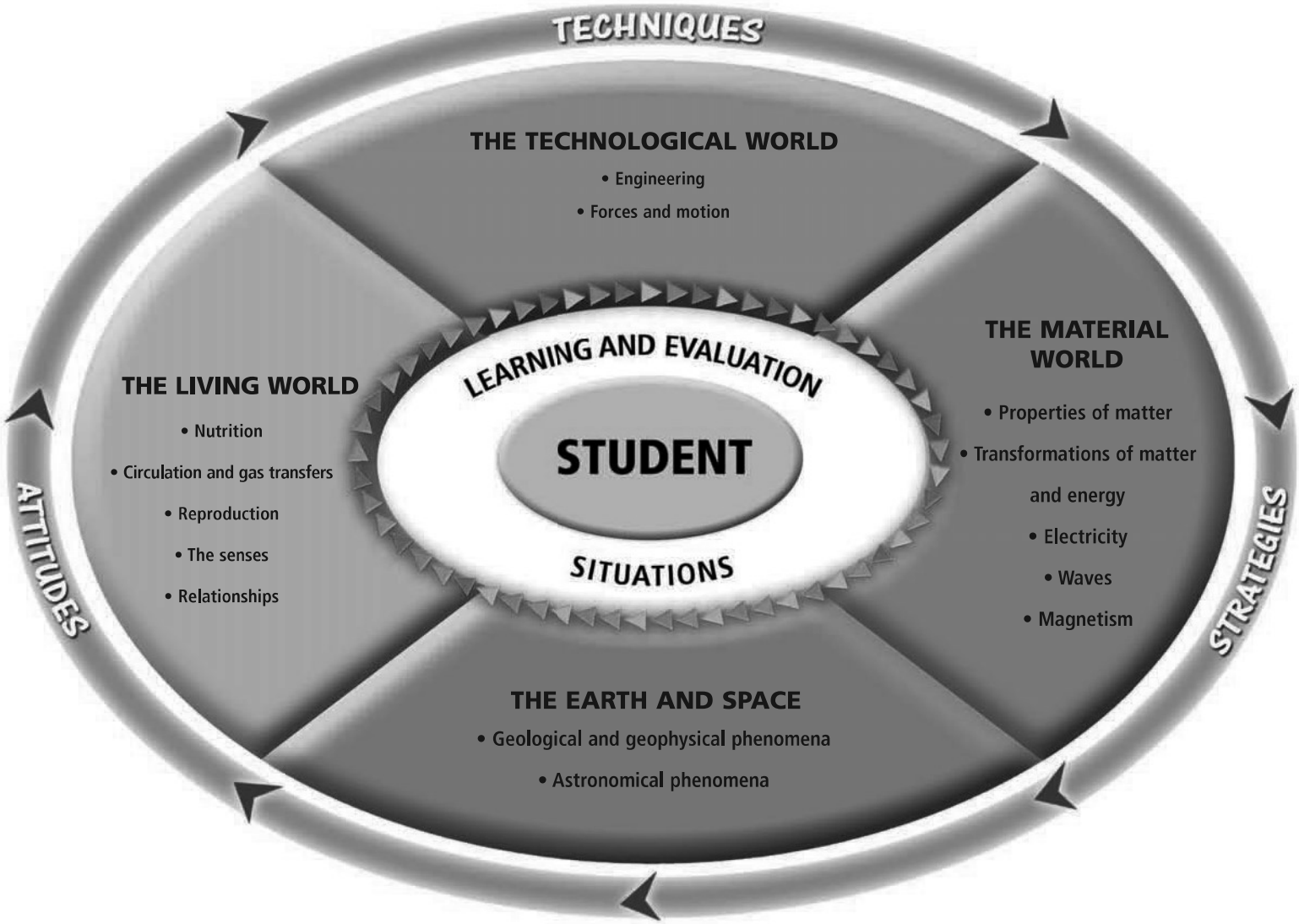
Program Content

The job market provides a number of scientific and technological challenges, and students enrolled in Prework Training should be aware of them. The Technological and Scientific Experimentation program offers a set of resources comprising concepts, strategies, techniques and attitudes in different learning and evaluation situations. The teacher may select the elements that meet students' specific needs, based on their environment and, in particular, on the economic activity in the region.

The following diagram illustrates the general structure of the program content, which is divided into two parts. The first set of tables groups the concepts together in four major areas: The Material World, The Living World, The Earth and Space, and The Technological World. The program content was organized in this way to make it easier for teachers to identify the key concepts that students should learn. These areas should not be examined separately or sequentially. The concepts should be covered in integrated learning and evaluation situations. Each area is presented in a four-column table: General Concepts, Orientations, Specific Concepts and Cultural References.

The second set of tables lists strategies, techniques and attitudes. As important as the concepts, these content elements play a crucial role in competency development.

STRUCTURE OF THE PROGRAM CONTENT



The Material World

Knowledge of the material world enables students to take a different view of the substances and materials found in their environment. In studying the properties of matter and the changes it undergoes, students can understand their usefulness and the importance of safety rules.

The Material World			
General Concepts	**Orientations**	**Specific Concepts**	**Cultural References**
Properties of matter	Several commercial products (e.g. detergents, pesticides, paints, solvents, aerosols, metals, oils) can be found at school, at home or in the workplace. Inappropriate use of these products can result in serious consequences and health problems. Safety pictograms on the products help us classify them (flammable, corrosive, toxic) and take the necessary precautions when using them. Some products are incompatible (e.g. chlorine bleach and ammonia) and precautions must be taken when storing and disposing of them in order to reduce the risk of injury. Acidity and alkalinity (basicity) are properties of several liquids. The pH scale is used to measure the degree of acidity of a product and to classify it (e.g. as a strong base or a weak acid). The pH level can be measured using coloured indicators (litmus) in solution or in strips. The concept of pH is applied in a number of sectors of activity (e.g. pool maintenance, greenhouses, cosmetics). Where facilities are available, substances and materials can be recycled. Society has everything to gain by recovering and reusing paper, metal, plastics and other materials rather than allowing them to accumulate in the environment.	– Categories of commercial products – Safety pictograms – Acidity/alkalinity (pH scale) – Recyclable materials	*Environment* – Acid precipitation *Applications* – WHMIS[1] – Labelling of household products – Separate collection

1. Workplace Hazardous Materials Information System. See the Web site of the Commission de la santé et de la sécurité du travail (CSST).

The Material World			
General Concepts	**Orientations**	**Specific Concepts**	**Cultural References**
Transformations of matter and energy	Influenced by certain factors, substances and materials undergo changes. Some of these changes occur naturally, but it is also possible to affect these changes. Bending, moulding, preparing or separating mixtures (filtration, decantation) and phase changes (solidification, boiling) are all examples of physical changes. Chemical changes involve transformations to the nature of the initial substances. Rust (oxidation) can be delayed using rustproofing paint. The fire triangle represents the three factors necessary for combustion: fuel (gas, wood), an oxidizing agent (oxygen, chlorine) and heat. Firefighters attempt to eliminate one of these three factors in order to put out a fire. Composting is a form of chemical recycling that uses fermentation to break down kitchen waste, changing it into compost that can be used to fertilize plants. There are several ways of obtaining compost, helping to reduce the quantity of household garbage. Heat is often produced during these changes. By limiting heat exchange with the surrounding environment, thermal insulation makes it possible to keep liquids hot, limit water heater energy loss, prevent ice from forming and preserve foods.	– Physical changes • Phase changes • Deformation • Mixtures, solutions and alloys – Chemical changes • Oxidation • Combustion (fire triangle) • Composting – Thermal insulation	*Applications* – Food processing – Fire prevention – Fighting forest fires *Society* – Water treatment
Electricity	Electrical charges can appear on certain neutral materials after they are rubbed with other materials. These charges are either positive or negative, and produce an electrical field. They attract when they are of opposite signs and repel when they are of the same sign.	– Types of electrical charges • Positive and negative charges • Forces of attraction and repulsion • Electrical field	*Applications* – Lighting systems – Communications systems (e.g. television, sound system, radio) – Heating systems

The Material World			
General Concepts	**Orientations**	**Specific Concepts**	**Cultural References**
Waves	Light phenomena are an everyday occurrence: reflections in a mirror; refraction producing a deformed image of objects under water or under a magnifying glass; dispersion; shadow. The electromagnetic spectrum includes various ranges of radiation, of which white (or visible) light is only one part. These waves differ in terms of the energy they carry and their ability to penetrate matter. The different categories of radiation (radio waves, microwaves, infrared, visible light, ultraviolet, X-rays and gamma rays) have numerous applications in everyday life.	– Light (shadow, reflection, refraction, dispersion) – Electromagnetic spectrum	– Environment – Natural radioactivity *Applications* – Sunscreen – Telecommunications (e.g. cell phones, satellites)
Magnetism	Some objects have the property of attracting iron, cobalt and nickel, or alloys of these metals. Whether natural or artificial, magnets have a magnetic field and two poles: north and south. Different poles attract, while similar poles repel.	– Magnets – Poles – Attraction, repulsion	– Environment – Earth's magnetic field *Applications* – Compass – Speaker

The Living World

In studying the human body, the students will come to realize that the survival of living organisms is made possible by the functions of nutrition, respiration and reproduction. They will understand how their sense organs provide information about the environment and enable them to relate and adapt to it. They will observe that the survival of living organisms and the quality of their physical surroundings are closely linked to human activity. Finally, they will learn to respect other living species and to act in an environmentally responsible manner.

The Living World			
General Concepts	**Orientations**	**Specific Concepts**	**Cultural References**
Nutrition	Nutrition helps ensure physical well-being and provide the energy required to carry out everyday activities. A healthy, balanced diet is essential to human growth and development. Food is processed in four stages (ingestion, digestion, absorption and elimination) as it makes its way through the digestive system, where it undergoes mechanical and chemical changes. The digestive tract and the other organs involved in the process play an important role, as do the digestive glands, such as the liver and pancreas.	– Types of foods (water, protein, carbohydrates, fats, vitamins, minerals) – Digestive tract (mouth, esophagus, stomach, small intestine, large intestine) – Processing (mechanical and chemical changes)	*Physical and mental health* – Drugs and poisons – Vitamins and supplements – Healthy, balanced diet *Applications* – Food preservation – Genetically modified organisms (GMOs)
Circulation and gas transfers	The transportation (respiratory and circulatory) systems, which allow organisms to exchange substances and energy with their environment, are essential for sustaining life. Oxygen and carbon dioxide are transported by the circulatory system through different types of blood vessels. Healthy circulatory and respiratory systems help the heart and blood vessels stay healthy and reduce the risk of cardiovascular disease. The excretory system filters the blood by evacuating cell waste and producing urine. It plays a crucial role in maintaining an internal balance.	– Respiratory system (nasal cavities, larynx, trachea, bronchi, lungs) – Circulatory system (heart, veins and arteries, types of blood vessels) – Excretory system (kidneys, ureters, bladder, urethra)	*Physical and mental health* – Cardiopulmonary resuscitation (CPR) *Environment* – Air quality • Automobile and industrial pollution • Smoking
Reproduction	Hormones are transported by the blood and transmit information from the brain to various organs, such as the skin, breasts, testicles and ovaries, thereby regulating the reproductive system. In studying the ovarian and menstrual cycles, sperm production, fertilization and the stages of pregnancy, students can be introduced to issues relating to male and female sexual maturity, a healthy reproductive system and family planning. In most	– Reproductive organs – Hormone regulation • Testosterone, estrogen, progesterone • Ovarian cycle • Menstrual cycle	*Human populations* – Decrease in the birth rate – Overpopulation *Applications* – Means of contraception – The fight against AIDS

The Living World			
General Concepts	**Orientations**	**Specific Concepts**	**Cultural References**
Reproduction	Western societies, birth control is a question of quality of life, and sometimes even of survival, and different methods are available to those who are interested.	– Fertilization – Pregnancy – Stages of human development – Contraception • Infections transmitted sexually and through the blood	*Community resources* – The school's complementary services – Public health (CLSC)
The senses	The human body reacts to stimuli from the environment received through its sensory receptors. Our senses include taste, sight, touch, smell and hearing. Poor lighting or ventilation, prolonged exposure to excessively high-pitched or loud sounds, and many other factors can alter our sensory systems. Knowledge of the structures of these organs and how they work gives a sense of the need to take care of them (e.g. by adopting healthy lifestyle habits).	– Sensory receptors (eyes, nose, tongue, skin, ears)	*Physical and mental health* – Commission de la santé et de la sécurité du travail (CSST) • Safety glasses and boots • Ear protection – Everyday life • Volume (sound system, radio, television) • Lighting • Appropriate clothing
Relationships	The circulation of matter (water, soil, air) and energy (light, heat) in nature is based on balanced relationships between plant and animal species and the physical environment of an ecosystem. Students study the influence of various factors, such as sunshine, temperature, precipitation, wind and type of soil on the growth of a plant species, thereby learning accountability for the protection of fauna and flora. On a global scale, human activity has an impact on the balance of ecosystems. It is important to consider concrete individual actions in a context of environmental education.	– Relationships between living organisms in plant and animal communities – Influence of nonliving factors on living organisms – Land and marine ecosystems	*Community resources* – Québec flora and fauna – Biodôme de Montréal – Zoos – Botanical gardens – Aquariums – Natural history museums *Environment* – International treaties on environmental protection – Landscaping – Parks and protected zones – Gardening

The Earth and Space

Knowledge about the Earth and space enables students to learn about the variety and fragility of our planet's resources. It provides an opportunity to reflect on the major issues of the day, such as pollution and energy choices.

The Earth and Space			
General Concepts	**Orientations**	**Specific Concepts**	**Cultural References**
Geological and geophysical phenomena	The Earth is a complex and fascinating system made up of soil (the lithosphere), water (the hydrosphere) and air (the atmosphere). All of these components provide numerous natural resources we can use, for example, minerals in the subsoil, forests, arable land, waterways and wind. A study of the water cycle and a few meteorological principles show how much these complex systems are influenced by human activity.	*Resources of the lithosphere* – Types of soils – Basic minerals – Precious and semi precious stones *Hydrosphere* – The water cycle *Atmosphere* – Composition – Meteorology	*Applications* – James Bay – Natural resources in Québec (mines, forests) – Wind energy *Events* – The ice storm of 1998 – The Saguenay flood of 1996 *Geography* – St. Lawrence River – Geological regions
Astronomical phenomena	With the seasons, constellations, planets and other objects visible to the naked eye cross the night sky. Star identification devices can be helpful, but it is useful to be familiar with a few landmarks such as the Big Dipper, the Little Dipper and the North Star, which points north. A study of the Earth's movement helps explain a number of phenomena, such as the alternation of day and night, the phases of the moon, eclipses, the tides and the seasons.	*Visible to the naked eye* – Stars – North Star – Constellations – Star identification devices – Phases of the moon – Eclipses – Seasons – Northern lights *Solar system* – Planets – Movement of the Earth (revolution, rotation)	*Community resources* – Astronomical observatories – Scientific pastimes – Web sites *Events* – Manicouagan crater – Charlevoix astrobleme *Applications* – Canadian Space Agency – International Space Station *History* – Conquest of space

The Technological World

By becoming familiar with the technological world, students learn that technology is an integral part of the world around them. They learn what they need to design and build a prototype of a technical object.

The Technological World			
General Concepts	**Orientations**	**Specific Concepts**	**Cultural References**
Engineering	Specifications[2] and schematic diagrams are used to record or represent the relevant elements of a technological design or analysis process. The discovery of new types of materials or new properties made it possible to improve the performance of technical objects in different spheres of activity. In electricity, the concepts are related to the different components of an electrical circuit and their functions. For example, fuses prevent circuit overloads.	– Specifications – Schematic diagram – Raw material – Material *Electricity* – Supply – Conduction, insulation and protection – Control	*History* – The evolution of machines and tools and its impact on trades – Inventions – Joseph-Armand Bombardier *Economy* – Canadian Intellectual Property Office (CIPO) *Applications* – Power tools – Small household appliances
Forces and motion	An analysis of technical objects provides concrete evidence of the presence of forces and motion. The forces that act on the parts of a mechanism modify their motion and exert mechanical constraints that may cause heating, deformation or ruptures. The application of the concept of forces and motion helps students understand certain simple machines and how transmissions (gears, pulleys, ball bearings, worm gears) work.	– Simple machines (e.g. lever, screw, wedge) – Mechanisms for the transmission of motion	*Sports and leisure activities* – Transportation technology (bicycle, sailboard, skateboard) *History* – Industrial Revolution

2. Text containing the desired function as well as all the requirements and constraints associated with the design and use of a technical object.

Strategies, Techniques and Attitudes

Strategies

A number of strategies in the Technological and Scientific Experimentation program help students develop the three subject-specific competencies. These strategies are divided into three categories: exploration and problem-solving strategies, instrumentation strategies and communication strategies.

Exploration and problem-solving strategies	– Breaking down a complex problem into simpler subproblems – Establishing the constraints involved in solving a problem or producing an object – Using various methods of reasoning – Illustrating the problem in a drawing or diagram – Formulating questions or hypotheses – Becoming aware of their initial representations – Thinking of similar problems they have solved – Exploring various possible solutions – Anticipating the results of the process – Making adjustments to the process when necessary – Thinking about their mistakes
Instrumentation strategies	– Using a variety of information sources, techniques and observation tools – Using drawing techniques to illustrate a solution – Using an ideas manager[3] – Using recording tools
Communication strategies	– Organizing data for presentation – Exchanging information – Comparing different possible explanations or solutions – Using a variety of means of communication, for example, doing a presentation using an ideas manager and a multimedia projector – Using tools to draw a diagram or represent data

3. http://www.recitadaptscol.qc.ca/spip.php?article21

Techniques involve methodical procedures that provide guidelines for the effective application of theoretical knowledge. The following table presents the work methods used in the learning and evaluation situations.

Science	Technology	
	Graphical language	**Manufacturing**
– Collecting samples – Separating mixtures – Using lab equipment safely – Using measuring instruments (scale, graduated cylinder, thermometer) – Using observation instruments	– Reading drawings – Drawing diagrams (drawings, sketches) – Using drafting instruments (rulers, squares) – Using terminology and symbols	– Using tools and simple machines – Measuring and marking out – Machining and shaping – Finishing – Assembling and disassembling

Attitudes

The attitudes in the Technological and Scientific Experimentation program are divided into two categories: intellectual attitudes and behavioural attitudes. Intellectual attitudes involve openness to the diversity of knowledge, points of view and approaches possible in dealing with scientific and technological problems. Behavioural attitudes involve students' manner of conducting themselves and contribute to personal development, life skills and work skills. The two types of attitudes are complementary.

Intellectual Attitudes	Behavioural Attitudes
– Curiosity – Initiative – Interest in comparing ideas – Creativity – Concern for objectivity – Use of the appropriate language	– Discipline – Autonomy – Perseverance – Sense of responsibility – Sense of effort – Cooperation – Observance of health and safety rules – Respect for life and the environment – Attentiveness – Team spirit – Interest in the social and environmental issues of the day