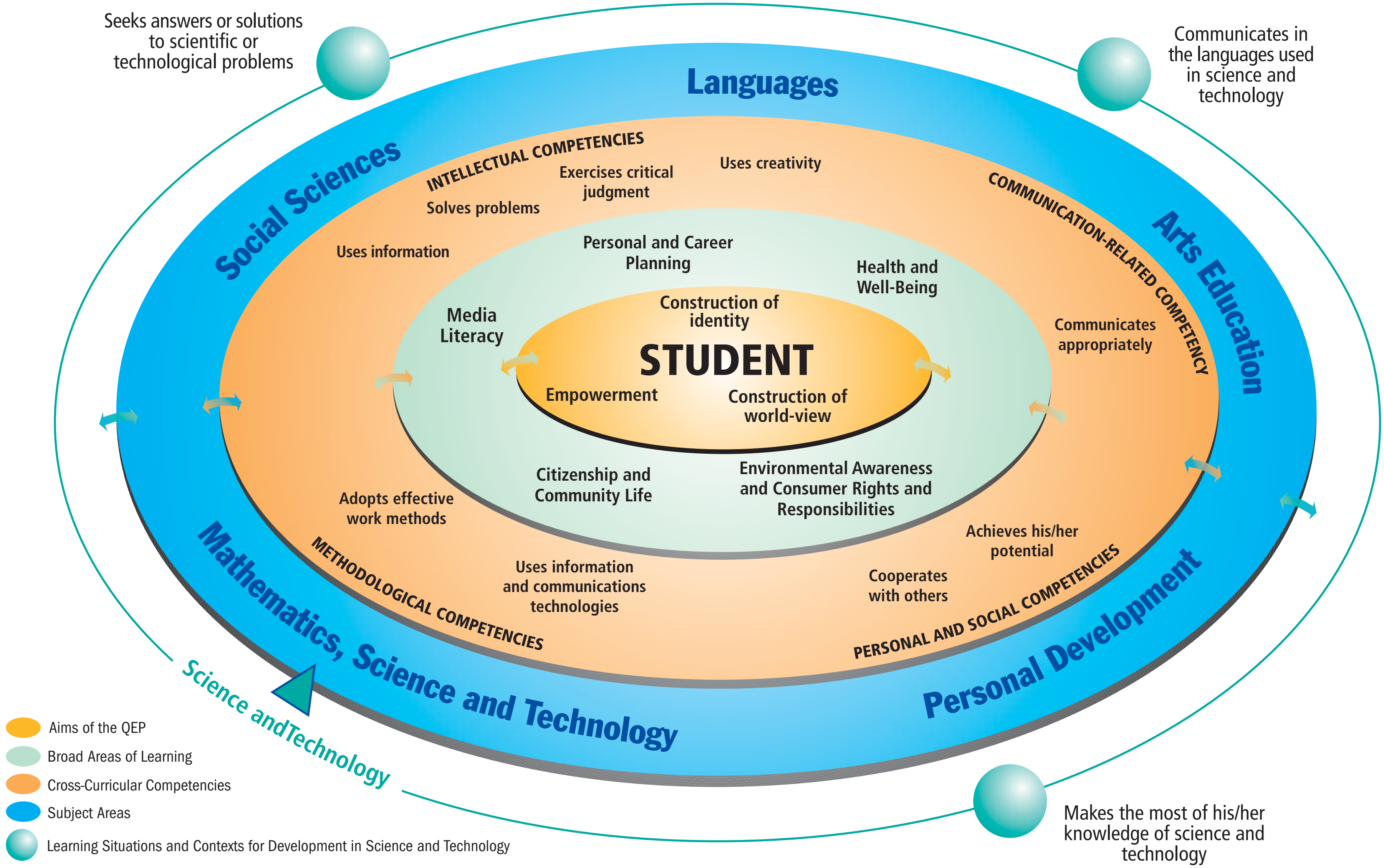

# Science and Technology

# Making Connections: Science and Technology and the Other Dimensions of the Québec Education Program (QEP)



# Introduction to the Science and Technology Program

Science and technology play an ever-increasing role in our lives and have made a key contribution to the transformation of societies. They can be found everywhere, be it in the multiplicity of objects that make up our everyday environment or in the many different spheres of human activity. However, the pace of scientific and technological development has increased so substantially that many people feel overwhelmed by the rapid emergence of large amounts of complex knowledge. They do not necessarily have the understanding and perspective needed to appreciate the impact of science and technology as well as their scope and limitations. This makes it difficult for them to adopt a critical attitude vis-à-vis the ethical questions raised by science and technology and undermines their ability to actively participate in making certain decisions that affect the democratic society in which they live.

The Science and Technology program creates a single discipline by integrating five scientific fields (chemistry, physics, biology, astronomy, geology) and various technological fields (e.g. mechanical design, medical, food and mining technology) studied in the context of cultural references. The curriculum is organized in this way because these fields complement one another, dealing as they do with many of the same concepts, and because it is often necessary to refer to subject matter and methods from several fields at once to solve problems or explain natural phenomena. In its effort to explain the world around us, science often relies on technological advancement. The world of technology attempts to respond to our needs by designing technical objects and striving for technological achievement, but it in turn makes use of scientific principles, laws and theories by providing opportunities for their application. In fact, science and technology are so interdependent that it is often difficult to make a clear distinction between the two.

It is important to remember that science and technology speak to us all to varying degrees. Scientists are not the only ones who may be curious about the phenomena around us or fascinated with scientific and technological innovation. To remain autonomous, each individual needs to understand the living and material environment with which he or she interacts, to retrace the origins of life and its evolution, and to learn to appreciate the complex relationships between living things and their surroundings.

Scientific and technological activities are not fundamentally different from other human activities. They are both part of a social and cultural context and are the result of a community's efforts to work together to build new knowledge on the basis of previously acquired knowledge. As is the case with an individual's learning process, knowledge in these areas is not developed in a linear or cumulative manner. Strongly influenced by the historical, social, cultural, political and religious context in which it emerges, scientific and technological knowledge sometimes progresses slowly, through successive approximations, and sometimes expands by leaps and bounds; it may go through periods of stagnation, which can then be followed by spectacular advances.

Imagination, creativity, the desire to explore and the pleasure of discovery are just as much a part of these activities as is the need to understand and explain. In this regard, the field of science and technology is not the preserve of a small group of experts, and one can take an interest in it without necessarily aiming for a scientific or technological career. Interest in science and technology can be developed in various ways, and it is the school's responsibility to explore these different avenues. By providing young people with the opportunity to acquire scientific and technological literacy, schools are helping them make a smooth transition from the classroom to life in society. As integral parts of the societies they have played a major role in shaping, science and technology represent both an important aspect of our cultural heritage and a key factor in our development.

In elementary school, students examined problems related to their broader natural or man-made environment through observation or hands-on activities. They suggested explanations for or solutions to scientific or technological problems. In so doing, they constructed their own knowledge, became familiar with concepts and continued to learn about the tools and methods of science and technology (e.g. experimental, observational, design, analytical and project procedures). During hands-on activities, the students familiarized themselves with safety rules and instructions.

The Science and Technology program for Secondary Cycle One, like the elementary-level program, is aimed at helping students develop basic scientific and technological literacy that should be within everyone's reach. It is important to encourage students to gradually build on this basic knowledge, to make them aware of how it can improve their ability to make informed decisions and to have them discover the enjoyment that can be derived from the study of science and technology. The program focuses on the development of three interrelated competencies associated with various complementary aspects of science and technology (i.e. practical and methodological aspects; theoretical, conceptual and historical aspects; and aspects relating to communication). Although the overall goals connected with these three competencies are essentially the same at both the elementary and secondary levels, the requirements pertaining to their development are more demanding at the secondary level.

The three competencies to be developed in Secondary Cycle One are as follows:

- Seeks answers or solutions to scientific or technological problems
- Makes the most of his/her knowledge of science and technology
- Communicates in the languages used in science and technology

The first competency focuses on methodology. The students become familiar with concepts and strategies through the inquiry and design processes used by scientists and technologists respectively. In science, the *inquiry process* refers not only to the experimental method, but also to exploration and observation in the field, surveys, studies and so on. For the study of technology in Cycle One, the design process was favoured because it is a rich and effective way of exploring abstract concepts in a concrete, hands-on manner. However, it is not the only way of studying technology. In general, the development of this competency requires the students' active involvement. They must ask themselves questions and determine the answers through observations, hands-on activities, measurements, construction or experimentation, be it in a lab, in a workshop or in the real world.

The second competency emphasizes the students' ability to conceptualize and apply what they have learned, especially in everyday life. It also involves examining the very nature of scientific and technological knowledge, its evolution and its numerous social and economic consequences. The students become familiar with the concepts involved in understanding natural phenomena and analyze the inner workings of technical objects. These concepts are regarded as tools that enable students to better understand the world and make informed judgments. Furthermore, these concepts are not studied separately, but rather in terms of the ways in which they are interrelated when it comes to solving certain problems or designing specific objects.

Inextricably linked to the two previously described competencies, the third competency focuses on communication. More specifically, it refers to the different types of language used in this area, which are essential for sharing information as well as interpreting and producing scientific or technological messages. It involves not only knowledge of specialized terminology and symbolism, but also the ability to use them intelligently, for example, by learning to adapt one's level of language to a specific audience.

These competencies are developed together and not in isolation or sequentially. In order to master the methods and procedures specific to science and technology, students need to know and to be able to use the related concepts and languages. They become familiar with these methods and procedures by using different contexts that give them meaning and importance.

Lastly, these competencies are inextricably linked to the topics covered in the Science and Technology program. These topics are related to various branches of science and technology (geology, astronomy, biology, physics, chemistry and different types of technology). They have been grouped together to form one subject (science and technology), which connects these fields of knowledge by focusing on questions pertaining to the material world, the living world, the technological world as well as the Earth and space. The compulsory concepts make it possible to illustrate how various phenomena are related to these various questions. These concepts, each in their own way, are an essential resource for the development of the competencies.

The students will continue to develop the competencies in Secondary Cycle Two, building on the concepts and procedures introduced in Secondary Cycle One. The different branches of science and technology and their related content will be examined in terms of their impact on individuals and society.

# Making Connections: Science and Technology and the Other Dimensions of the Québec Education Program

In a variety of ways, Science and Technology is related to the other dimensions of the Québec Education Program (i.e. the cross-curricular competencies, the broad areas of learning, mathematics and the other subject areas).

## Connections With The Broad Areas of Learning

Because of the ways in which science and technology affect the economy, the environment as well as human health and well-being, there is significant overlap between the issues associated with the broad areas of learning and those raised by science and technology in our everyday lives. The knowledge that students acquire in studying science and technology can be of great help in understanding the many issues related to adolescent health, sexuality and well-being. This knowledge also makes them more conscious of the interdependence of systems on a global level, thereby increasing their environmental awareness. Issues such as waste management, the reduction of polluting emissions, the depletion of the ozone layer, the protection of wildlife and plant life, and ethical questions related to biotechnology affect the relationship between human beings and the universe. These questions deserve to be examined in terms of individual and collective responsibilities and the need to promote sustainable development. With regard to consumer rights and responsibilities, the students can make informed choices and be intelligent consumers by making use of what they learn about science and technology. This will enable them to take a more critical view of the information provided by the media, which has a significant impact on how students relate to the world around them.

In the area of personal and career planning, the variety of activities that students are asked to carry out in order to develop their competencies in science and technology deal with situations that can help them better understand the nature of scientific and technological work. These activities involve requirements as well as challenges and bring a certain measure of satisfaction that enables students to discover their interests and aptitudes and to develop them, thereby helping them chart their academic and career path. By taking responsibility for their own future, their health, their environment, and their consumption habits without allowing themselves to be influenced by the media, the students play a more enlightened role in the democratic life of society as a whole and, in so doing, learn to become responsible citizens.

## Connections With the Cross-Curricular Competencies

To develop their competencies in science and technology, students must make use of several cross-curricular competencies. For example, in seeking answers to scientific questions or solutions to technological problems, students develop their problem-solving skills and apply them to specific situations. Problem solving also calls for the ability to develop effective work methods. Students must plan their procedures, adjusting them if necessary, so as to be able to draw conclusions or compile results that can then be applied to new situations. In exploring various investigative approaches or production scenarios, the students use their creativity. They call upon their personal resources to experiment with new ideas or new concepts, which helps them achieve their potential. When they consider solutions or hypotheses, they are willing to take intellectual risks. They eventually learn to trust themselves and allow themselves to make mistakes.

Students must exercise critical judgment to make the most of their knowledge, especially when analyzing, even briefly, certain consequences of science and technology. They must focus on the facts and try to keep media influences, social pressures and conventional wisdom in perspective. They must use information intelligently when seeking answers or solutions to scientific or technological problems or when trying to understand the phenomena around them. In addition, to develop their knowledge of science and technology, students must cooperate with others, since the sharing of ideas or points of view, peer or expert validation as well as various collaborative research, experimental or design activities are part and parcel of the learning process. In order to understand concepts, students must familiarize themselves with the language of science and technology, which enables them to develop their ability to communicate appropriately.

The rapid development of information and communications technologies (ICT) has played a significant role in recent advances in the world of science and technology. As a result, the ability to use ICT can be an invaluable asset. They can facilitate the inquiry process in a variety of ways. They make it possible to process information quickly; to find, organize and store information; to create and use a database; to develop models; and to extend their senses through the use of peripherals. In addition, by joining a virtual scientific community, students can share information, communicate with experts on-line, exchange information, present the results of their work and compare them with those of their classmates by taking part in a discussion group or videoconference.

## Connections With the Other Subjects

To ensure that students receive an integrated education, it is important to connect scientific and technological learning to learning in other subjects. Since any subject is defined, among other things, by the way in which it perceives reality and by its particular view of the world, other subjects can shed additional light on science and technology just as science and technology can also help us better understand other subjects.

In this regard, there are a number of interesting ways in which the Science and Technology program is related to geography as well as history and citizenship education. Because it focuses specifically on the natural world, the Science and Technology program provides knowledge that can be applied in the Geography program to help students understand the organization of a territory and certain territorial issues. Connections can also be made with history and citizenship education, since science and technology are important social phenomena. For example, the study of scientific and technological developments can shed new light on the history of different societies. Conversely, historical perspective contextualizes developments in science and technology.

If science and technology also benefit from the creativity that arts education makes a special point of promoting, they in turn contribute to an understanding of the arts. For example, musical instruments can be regarded as technical objects designed to meet certain needs, and it may be useful to have a better understanding of how they work.

The same applies to physical education and health. By studying the materials used to make various types of sports equipment, the students are able to better understand how these materials affect the forces and movements involved in their different sporting activities.

Other subjects also provide students with tools essential to the development of their competencies in science and technology. English and French, for instance, allow students to acquire language skills that will be useful to them in various scientific and technological activities. Whether the students are reading, writing or communicating verbally, the competencies they develop in English Language Arts are indispensable for acquiring relevant information, describing or explaining a phenomenon, or justifying a methodological decision. Furthermore, knowledge of French is an asset given the wealth of information on science and technology available in this language.

For its part, mathematics provides a body of knowledge useful for the study of science and technology. For example, mathematics can be used to model relations between variables. In addition, when students follow a scientific or technological procedure, they must often measure and count, calculate averages, apply geometric concepts and visualize space, and they must choose different types of representations at various steps in this procedure. Its vocabulary, graphs, notation and symbols also make mathematical language a tremendous asset to science and technology.

Lastly, the competencies developed in moral education and religious instruction can be of great use in studying science and technology, especially because of the many ethical questions examined (e.g. human actions that affect reproduction or the environment).

# Pedagogical Context

The Science and Technology program develops the students' curiosity, creativity, critical sense and independence and encourages their active participation in the learning process. As a result, efforts should be made to devise contextualized, open-ended and integrated learning situations leading to a variety of activities that stimulate the students' interest and give concrete meaning to what they are studying.

## Features of Learning and Evaluation Situations

A situation is contextualized if it focuses on natural phenomena, current events, everyday problems or the major issues of the day. Concerns relating to consumption, the environment, health and well-being, the economy and responsible resource management are examples of subjects that involve science and technology and that can arouse the students' interest.

A situation is open-ended when it is based on given information that can lead to different ways of solving a problem. The situation can involve complete, implicit or superfluous information. In cases where there may not be enough information to solve the problem, students will have to do additional research, which will allow them to acquire new knowledge. In order for this information to be analyzed, it must be sorted out so that the relevant data can be identified.

A situation is integrated when it involves making use of knowledge related to the four different worlds that make up the program content (i.e. technological world, material world, living world as well as the Earth and space). The various types of knowledge must not only be applied, but also interrelated.

Lastly, a situation can give rise to a variety of learning activities. With regard to a given situation or problem, students may be required to play an investigative role while conducting a laboratory experiment, doing fieldwork or building a technical object in a workshop. Alone or with their classmates, students can actively look for explanations to satisfy their own curiosity about certain phenomena or about the operating principles of a device. They must use appropriate language whether they are writing a research report, formulating questions or offering explanations. They have the opportunity to share information orally or in writing when presenting a research project or taking part in a science fair or debate, for example.

## Role of the Teacher

In this type of situation, it is important to provide students with a framework that is both flexible and rigorous. It should be flexible in that the students should be able to ask questions and should have enough latitude to explore various possibilities and make choices. It should be rigorous in that the students should be required to comply with the rules and conventions that govern scientific and technological activity. The teacher must always ensure that the students are not overwhelmed by the amount of information involved. He or she is aware that they need help both to select relevant information for carrying out the project or solving the problem, and to seek new information. Although the situations are initially open-ended, they must eventually be specifically defined in terms of a project that can be completed or a goal that can be achieved with the help of appropriate resources.

While conducting a laboratory experiment or doing fieldwork, the students will have to help develop and carry out procedures. Their independence will be fostered by providing them with a variety of materials that allow them to consider different ways of solving problems. The teacher will guide students in their choices by focusing on those aspects of the process that, in his or her opinion, require more attention (the formulation of a hypothesis, the concept of a variable, the notion of measurement, the presentation of results). If necessary, he or she gives appropriate explanations to help them make progress. Opportunities for trial-and-error learning can be provided occasionally, meaning that time must be set aside to properly analyze sources of error.

Regarded as a creative process, the procedure for designing a technical object should focus on the search for imaginative ideas to satisfy a particular need. Before building the object, the students must analyze the problem involved and study the operating principles. They will be encouraged to exchange ideas, submit plans or diagrams outlining their proposals, compare their plans and diagrams with those of other students, and work in teams to examine different solutions.

## Using External Resources in the Classroom

Various cultural resources can also be exploited. Museums, research centres, engineering firms, medical facilities, local industries and businesses or any other organization in the community can be mobilized to develop the students' scientific and technological literacy. Scientists and technologists often consult specialists in the course of their work. Activities involving specialists will familiarize students with scientific and technological resources, introduce them to people with a passion for science and technology, and make them aware of career opportunities. A long-lasting relationship will hopefully be established between the world of education and the scientific and technological community.

## Evaluation in a Learning Context

Moreover, with regard to the science and technology curriculum, evaluation will be carried out in accordance with the orientations of the Québec Education Program. Evaluation is viewed as a learning tool and focuses on the development of subject-specific competencies. It should be pointed out that the mastery of concepts is essential to the development of these competencies. The same types of situations (contextualized, open-ended, integrated and involving a variety of activities) must be used in both ongoing and end-of-cycle evaluation. Evaluation also involves regulation so that necessary adjustments can be made throughout the competency development process.

## Example of a Learning Situation

The diagram on page 232 illustrates an example of a contextualized, integrated and open-ended learning situation that can give rise to a variety of learning activities. This type of situation makes scientific and technological concepts meaningful to the students because these ideas are incorporated into a context in which they can be concretely applied. The situation also allows the students to make connections with the educational aims related to the broad areas of learning and with other subjects. Moreover, it requires them to use cross-curricular and subject-specific competencies. The various dimensions of the Québec Education Program that can be connected to this learning situation are indicated in red type. It goes without saying that only some of these connections may actually be developed, depending on the focus given to this learning situation.

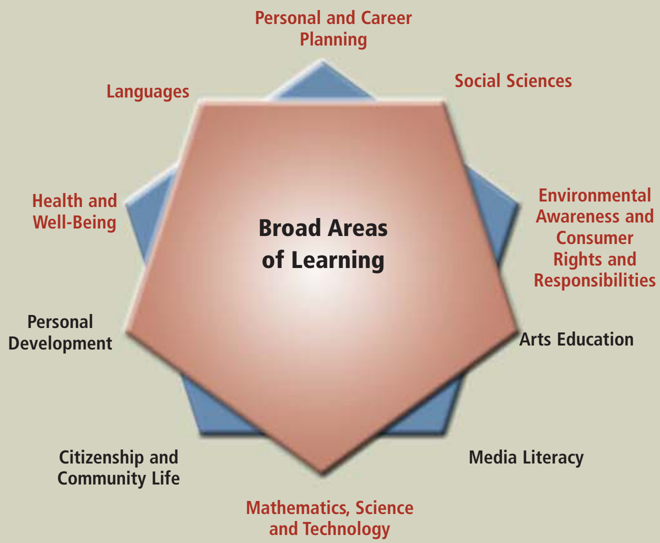
This situation is contextualized in that it deals with an everyday problem and is connected to several of the broad areas of learning (Health and Well-Being, Environmental Awareness and Consumer Rights and Responsibilities, Personal and Career Planning). It can also involve the cultural references listed in the program or other relevant cultural references. For example, the "food preservation" issue relates to "food processing," which is already indicated as a cultural reference. As a result of these connections, classroom learning can lead to activities that take place outside the school.

The situation is also integrated because it enables students to use and connect concepts pertaining to various parts of the program content: the material world (organization, properties and changes), the living world (diversity of life forms and life-sustaining processes) and the technological world (engineering and technological systems). To examine this situation, the students can use and interrelate different concepts (animal and plant cells, molecules and atoms, physical and chemical changes, states of matter, temperature, conservation of matter, mixtures, solutions, acidity and alkalinity, characteristic properties, mass and volume).

This situation can also be connected to mathematics. For example, if we wish to study dehydration as a method of preserving an apricot, it could be interesting to determine the percentage of residual water in this fruit at various stages in the process and to then establish the relationship between this percentage and the amount of time the apricot can be preserved. Other factors can be taken into consideration by those looking for greater challenges. This situation can also be connected to other subject areas such as the social sciences. For example, the problem of food preservation could be examined from a historical point of view by looking at how a sedentary way of life and the invention of agriculture changed people's lifestyles and created a need for food preservation techniques.

Lastly, the situation is open-ended because the given information is general enough for the problem to be tackled in several different ways (e.g. dehydration, sterilization, acidification). The teacher proposes a variety of learning activities, taking into account the students' prior knowledge. The situation can be simplified or enriched to meet the students' specific needs. Regardless of how the situation is introduced, the students will have to gather information, mobilize various internal and external resources, and acquire new knowledge to solve the problem safely. They will also have the opportunity to use and develop the three competencies outlined in the Science and Technology program.

# AN EXAMPLE OF A LEARNING SITUATION IN SCIENCE AND TECHNOLOGY



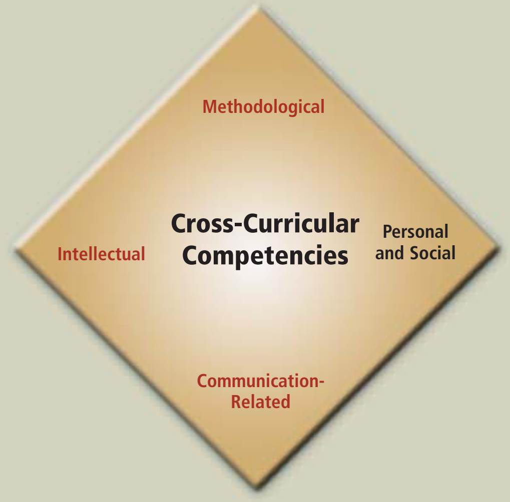

## Food Preservation

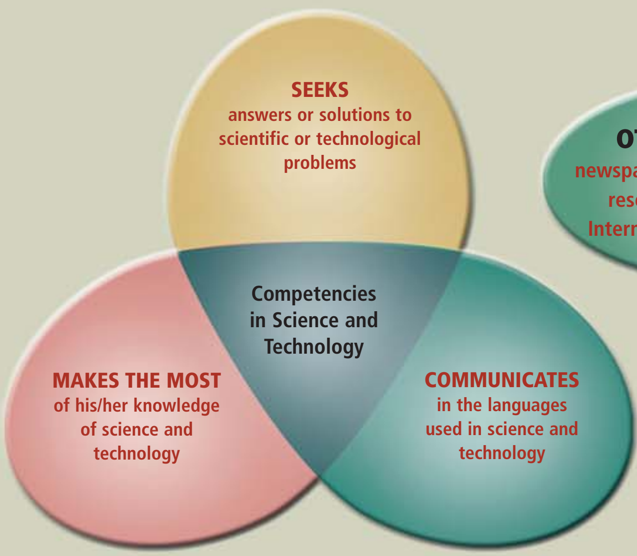
The food in our plate is essential to our survival, but it cannot be preserved forever. It soon ceases to be edible and, in some cases, becomes toxic or fatal to eat.

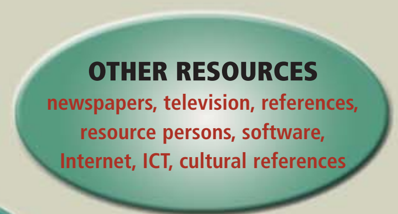
Its appearance changes, and it starts to smell bad. To slow down this decomposition process, humans have discovered various food preservation methods, which have considerably improved our health and our chances of survival. These methods have also had an impact on food consumption and the food trade.

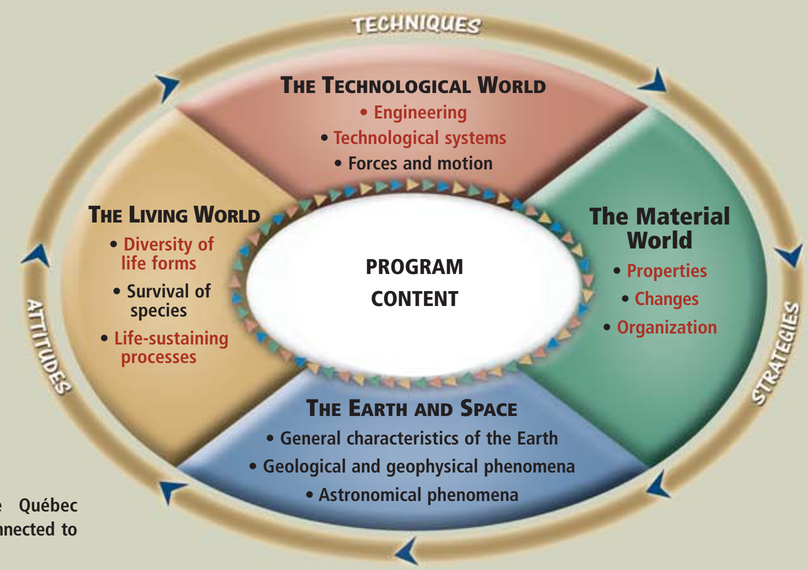
The best techniques for preserving specific types of food are devised by studying the causes of food decay as well as human needs.

Choose a method or build a device that can be used to preserve a specific type of food for as long as possible.




**IN RED:** Dimensions of the Québec Education Program that can be connected to the learning situation.

# COMPETENCY 1 Seeks answers or solutions to scientific or technological problems

## Focus of the Competency

The field of science and technology is characterized, among other things, by a rigorous approach to problem solving. These problems, which focus on a question or a need, involve initial information, a goal to be achieved and constraints. These procedures involve the use of investigative strategies that require creativity, a methodical approach, rigour, ingenuity, curiosity, perseverance and modesty. Learning how to carry out these procedures makes it possible to better understand the nature of scientific and technological activity.

Seeking answers or solutions to scientific or technological problems entails using the types of reasoning and methodological procedures associated with science and technology. Although they are based on systematic processes, these procedures are not foolproof and may involve trial and error. Their concrete application requires continuous questioning for the purpose of validating the work in progress so that necessary adjustments can be made in accordance with the stated goals or the selected options. The final result of an experiment or of a design process sometimes reveals difficulties that create new problems to be solved. Achievements are therefore always temporary and are part of a continuous process of acquiring and expanding our knowledge.

The students gradually develop this competency by working on relatively complex problems that require the use of an inquiry process for scientific work and a design process for technological work. These processes differ in terms of the types of problems and goals involved. The inquiry process is aimed at explaining phenomena and focuses on questioning, exploration, systematic observation and experimentation. The design process is used to build technical objects in response to individual or collective needs.

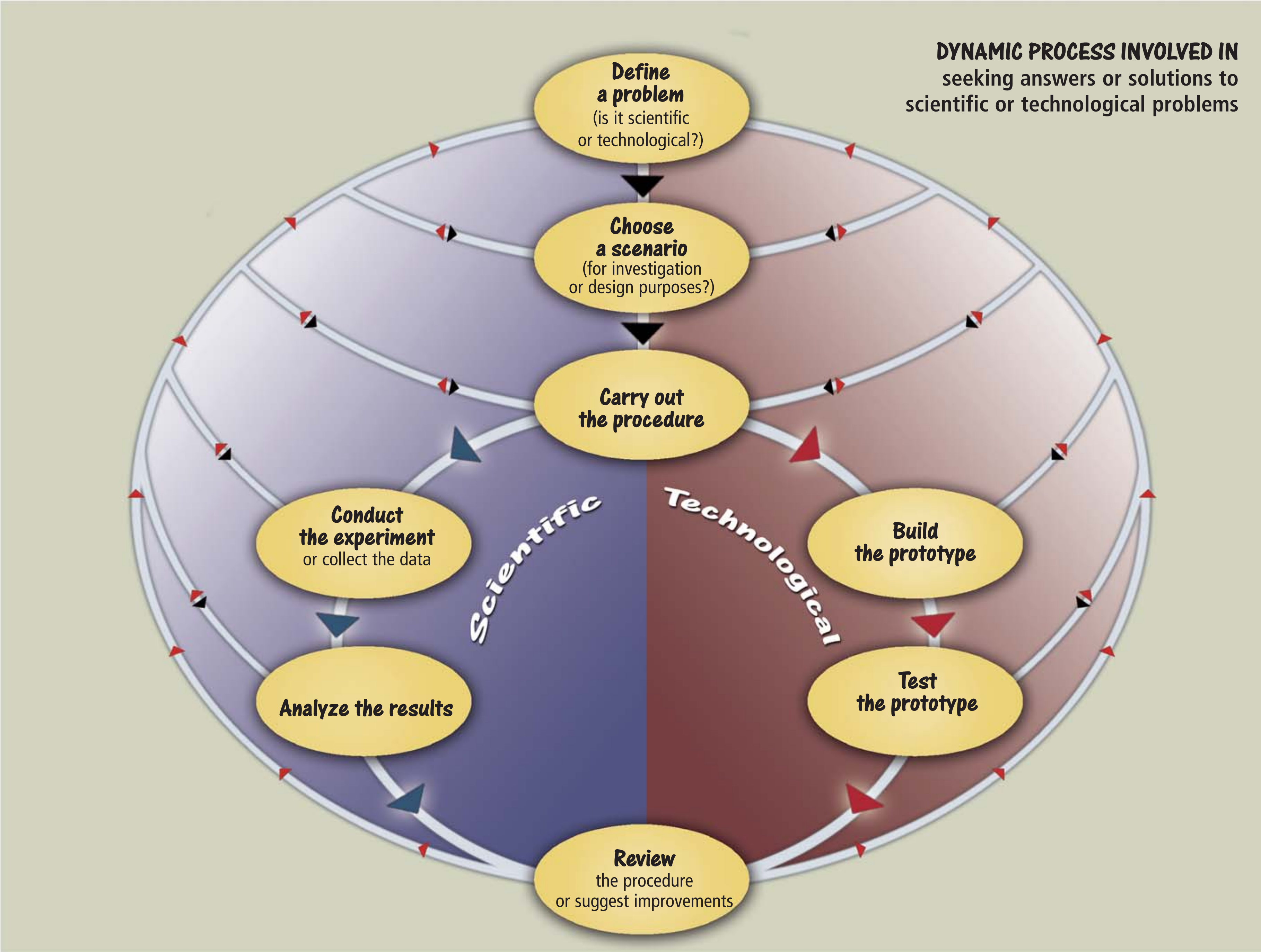
When engaged in a process of scientific inquiry, the students must first define a problem, looking for significant clues and identifying its key characteristics. This questioning process is essential for establishing a framework for experimentation or exploration that makes it possible to devise investigation scenarios. In gathering information and processing it systematically, the students will be able to validate their hypotheses and, if necessary, redefine the problem, adjust their investigative procedure and formulate new questions.

When engaged in a design process, the students identify a need to be satisfied. They consider different production scenarios, taking into account the constraints outlined in the specifications[1] or their own requirements and the available resources. The students must analyze these various scenarios in order to efficiently plan the work required to develop an imaginative solution. By examining their prototype in detail and testing it, the students can evaluate their proposed solution and determine whether it is consistent with the requirements outlined in the specifications. If necessary, they review their procedure and suggest improvements.

By comparing these two processes, students will realize that scientific inquiry and design work involve some of the same types of reasoning, but will also discover that they complement each other. While technology is based on scientific principles and benefits from the development of scientific knowledge, science in turn derives great benefit from technological advances. It often uses technology to solve practical problems, since an experimental procedure sometimes calls for the development of new tools. Moreover, when designing a technical object, it may be necessary to conduct a scientific experiment to check the properties of materials and ensure that they meet manufacturing requirements.

The following diagram illustrates the dynamics involved in seeking answers or solutions to scientific or technological problems. An analysis of the scientific inquiry and technological design processes shows that certain steps are similar and that others are clearly specific to each process. The feedback arrows indicate that this is not necessarily a linear, rigid sequence of operations, but rather a complex process in which one's work can always be called into question. As a result, the process provides an opportunity to learn from one's mistakes and to suggest improvements. This network of arrows also shows that it is possible to switch from one process to the other, for example, when conducting an experiment to determine which material should be used in designing a technical object. Similarly, the inquiry process can be facilitated by the design of a technical object like a measuring instrument.

1. Written description of the function of a technical object, including all the requirements and constraints involved in designing and using it.


DYNAMIC PROCESS INVOLVED IN
seeking answers or solutions to
scientific or technological problems
Define
a problem
(is it scientific
or technological?)
Choose
a scenario
(for investigation
or design purposes?)
Carry out
the procedure
Scientific
Technological
Conduct
the experiment
or collect the data
Analyze the results
Build
the prototype
Test
the prototype
Review
the procedure
or suggest improvements

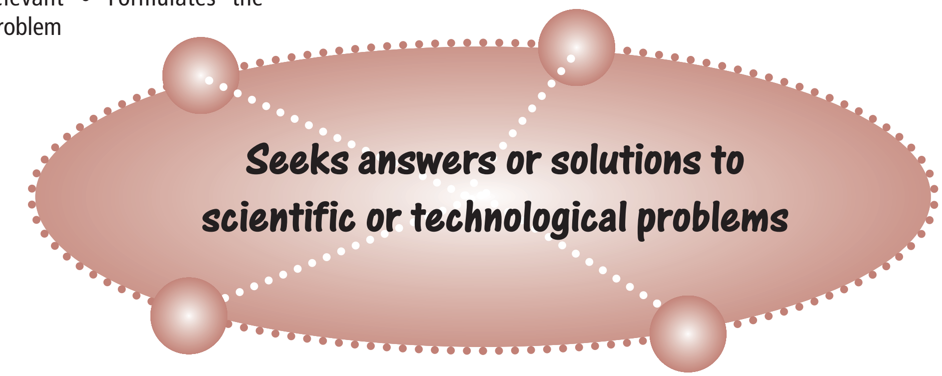
## Key Features of Competency 1

### Defines a problem

Identifies the scientific or technological characteristics of the problem • Recognizes the elements that seem relevant • Formulates the problem

### Chooses an investigation or design scenario

Considers different scenarios • Takes into account the constraints associated with each scenario • Chooses what he/she thinks is the best scenario for achieving the goal in question • Justifies his/her choices • Plans his/her procedure




### Carries out the procedure

Follows the steps in the plan • If necessary, adjusts his/her tests, reviews his/her plan or looks for a new way of solving the problem • Takes note of any detail or observation useful for analyzing the problem

### Analyzes his/her results or solution

Looks for significant trends in the data or tests the prototype • Examines the results in light of the procedure • Formulates new problems or suggests ways of improving the solution • Draws conclusions

– Appropriate representation of the situation
– Development of a suitable procedure for the situation
– Appropriate implementation of the procedure
– Development of relevant conclusions, explanations or solutions

## End-of-Cycle Outcomes

By the end of Secondary Cycle One, students engage in both a scientific inquiry process and a technological design process. They determine whether a given situation is scientific or technological in nature or whether it involves both these dimensions. They adjust their approach accordingly and switch from one process to the other if necessary.

With regard to the scientific inquiry process, students formulate relevant questions or offer tentative explanations, using them to form testable hypotheses or make plausible predictions. They are able to justify their hypotheses or predictions. They develop their procedure and, when appropriate, control at least one variable that can influence the results. In developing their procedure, they choose the tools, equipment and materials they will need from among the resources at their disposal and, if necessary, use information and communications technologies. They implement their procedure, working safely and making adjustments whenever necessary. They gather valid data by correctly using the tools or instruments they have chosen. They analyze the data they have gathered, using it to formulate relevant conclusions or explanations. If applicable, they then propose new hypotheses or suggest ways of modifying their procedure.

As for the technological design process, students define a need or become familiar with the specifications. They examine the need and, in light of this analysis, identify a problem to be solved. They take into account the constraints involved in making and using the technical object. They study its operating principles, draw diagrams illustrating them and identify the scientific and technological concepts involved. They consider a number of solutions and choose the one that seems the most appropriate. They study how the technical object will be made, which makes it possible to specify the shape and size of the parts, the required materials as well as the appropriate assembly techniques in accordance with the constraints. They build a prototype that is consistent with their solution, working safely in the process. If necessary, they adjust their procedure. They check if the prototype works and if the solution meets the identified need or conforms to the specifications.

# COMPETENCY 2 Makes the most of his/her knowledge of science and technology

## Focus of the Competency

Science and technology affect the social, economic and political aspects of our life. In some ways, they have helped significantly improve our quality of life but in other ways, they have given rise to problems or ethical issues, and we must try to see where we stand in relation to these questions. Every facet of human existence, be it personal, social or work-related, is influenced by science and technology to varying degrees. Their impact is so profound that they now appear to be indispensable tools for understanding the world in which we live and adapting to it. To be able to function in society and play our role as citizens, it is becoming essential to acquire scientific and technological literacy, which entails the ability to make the most of our knowledge of science and technology in a variety of everyday situations and to make informed decisions.

Making the most of one's knowledge of science and technology means being familiar with certain basic concepts needed to understand various phenomena or analyze technical objects. This knowledge cannot, however, be limited to the mastery of mathematical theories or the application of recipes. To understand a phenomenon, we must first attempt to visualize its characteristics so that we can grasp their interrelationships, and we must also be able to explain it using appropriate laws and models. To understand how a technical object works, we must be able to recognize its function and operating principles (i.e. recognize the scientific principles involved), identify its components and understand the relationships between these components. However, this knowledge cannot be truly useful to students unless they can appreciate its nature, origin and value and grasp its significance, especially in their everyday life.

In developing this competency, students also learn how scientific and technological knowledge is constructed, standardized, acquired and used and how it is related to other spheres of human activity. This knowledge is essential to an understanding of the relationships between science, technology and society. To be able to appreciate the different applications of science and technology and assess their many repercussions, it is important not to view scientific and technological knowledge in a vacuum without taking into consideration the social and historical contexts in which it is produced, conveyed and used.

Development of this competency is based on questions relating to the different ways in which humans interact with their environment. These questions are all the more likely to stimulate the students' interest and curiosity if they reflect their concerns and if the students can help formulate them. Moreover, certain concepts lend themselves especially well to an examination of their historical development, which provides students with an invaluable opportunity to explore the context in which these concepts emerged and the way in which they evolved over time. As a result, they will become aware of the fact that scientific and technological concepts are not absolute and will be able to relate their sometimes slow or sometimes rapid development to their own learning process.

## Key Features of Competency 2

### Identifies the effects of science and technology

Studies the long-term effects of science and technology on individuals, society, the environment and the economy • Places science and technology in their social and historical context and examines their impact on people's lifestyle • Identifies ethical questions or issues

### Understands how technical objects work

Demonstrates curiosity about certain technical objects • Examines how they work and how they are made • Takes them apart, if necessary • Identifies the materials, parts and different types of links in these technical objects • Illustrates them in a schematic diagram • Recognizes the different systems and subsystems • Explains how they work

**Makes the most of his/her knowledge of science and technology**

### Understands natural phenomena

Asks himself/herself questions about his/her environment • Examines certain phenomena • Describes their characteristics • Illustrates them in a schematic diagram • Explains phenomena using laws or models • Ensures that this explanation is coherent • Becomes familiar with relevant concepts and recognizes that they evolve

- Formulation of appropriate questions
- Appropriate use of scientific and technological concepts, laws, models and theories
- Relevant explanations or solutions
- Suitable justification of explanations, solutions or decisions

## End-of-Cycle Outcomes

By the end of Secondary Cycle One, students deal with situations or questions relating to natural phenomena, current events, everyday problems or the major issues of the day. They analyze them from a scientific or technological point of view by referring to one or more branches of science and technology.

When students analyze a situation from a scientific point of view, they define the phenomenon in question and identify the scientific components. They propose explanations or tentative solutions and then develop them on the basis of certain scientific concepts, laws, theories and models.

When students analyze a situation from a technological point of view, they determine the function of a technical object and examine how it works. They handle the object and, if necessary, take it apart to understand its main systems and mechanisms. They describe the operating principles of the object using relevant scientific and technological concepts. They explain the solutions they chose for making the object.

If applicable, students study the advantages and disadvantages of different possible solutions as part of the decision-making process. They identify the impact of their decision, focusing in particular on its environmental and ethical repercussions.

# COMPETENCY 3 Communicates in the languages used in science and technology

## Focus of the Competency

Communication plays an essential role in the construction of scientific and technological knowledge. To the extent that such knowledge is developed and instituted socially, a set of common meanings is required so that people can exchange ideas and negotiate points of view. This calls for a standardized language that defines terms in accordance with the way they are used in the scientific community. The dissemination of knowledge is also governed by certain rules. For example, research results must be validated by means of a peer review process before they are made public. Information can be communicated in different ways depending on whether it is meant for an audience of experts or non-experts.

Communicating in the languages of science and technology involves using the codes and conventions associated with these fields (e.g. International System of Units). This makes it possible to acquire knowledge by exchanging ideas with other people, to organize observations, to formulate explanations and to share results. Using these languages means being able to both produce and interpret scientific or technological information. Students must interpret information whether they are reading a scientific or technical article, trying to understand a laboratory report or using a set of specifications, a plan or a diagram. When developing a research procedure, writing a laboratory report or giving a presentation on an issue related to science or technology, they spend much of their time using their ability to produce information.

This competency is developed in situations where students discuss with their classmates the results of their work or the procedures they used or where they consult experts to find answers to their questions. Also, when presenting a project or preparing a science fair exhibit, for example, they must use scientific or technological language and adapt their message to their audience. In these situations, information and communications technologies can be useful or provide a more enriching learning experience. Moreover, by studying concepts or procedures, they gradually become familiar with the subject-specific language and its usage. This makes them more aware of the fact that the everyday meaning of a term is sometimes different from its meaning in scientific or technological language. Similarly, they learn to make connections between the meaning of concepts and their application, since concepts may have different meanings depending on the context involved.

This competency is inextricably linked to the other two competencies in this program and cannot be developed in isolation from them. When conducting scientific experiments or making a technical object, the students must follow certain conventions whether they are devising a research procedure or a production scenario, or presenting results. Tables, graphs, symbols, diagrams, technical drawings, scale models, mathematical equations and models can be used to clarify a message, but it is important to use them in accordance with the rules specific to the fields of science, technology and mathematics.

Concepts cannot be learned in isolation from a language and a certain type of discourse. For example, scientific laws are a way of modelling phenomena and are usually expressed through definitions or mathematical formalism. Understanding these laws means being able to connect them to the phenomena they represent. Students learn the language of science and technology in order to be able to use it and not simply to be able to understand its structure. Learning this language also involves establishing clear links between codes and symbols and the reality they represent.

## Key Features of Competency 3

### Participates in exchanging scientific and technological information

Understands the role of information sharing • Is open to other points of view • Compares his/her data and procedure with those of other people • Validates his/her point of view or solution by comparing them with others


### Divulges scientific or technological knowledge or results

Takes the target audience into account • Uses different ways of presenting information (e.g. symbols, tables, technical drawings) • Adapts the message to the type of medium used (e.g. written or oral presentation, Web page)

### Interprets and produces scientific and technological messages

Uses scientific and technological information taken from different sources • Makes sure these sources are credible • Assesses their relevance • Presents information in accordance with the rules and conventions of science, technology and mathematics

– Appropriate interpretation of scientific and technological messages
– Messages produced using proper vocabulary and in accordance with related rules and conventions

## End-of-Cycle Outcomes

By the end of Secondary Cycle One, students interpret and produce oral, written or visual messages relating to science and technology. They correctly use the languages associated with science and technology, including mathematical and symbolic language as well as everyday language. They produce clear, well-structured and well-worded messages and follow conventions. If necessary, they adapt their messages to their target audience. Using everyday language, they are able to explain the messages they have produced or interpreted.

## Program Content

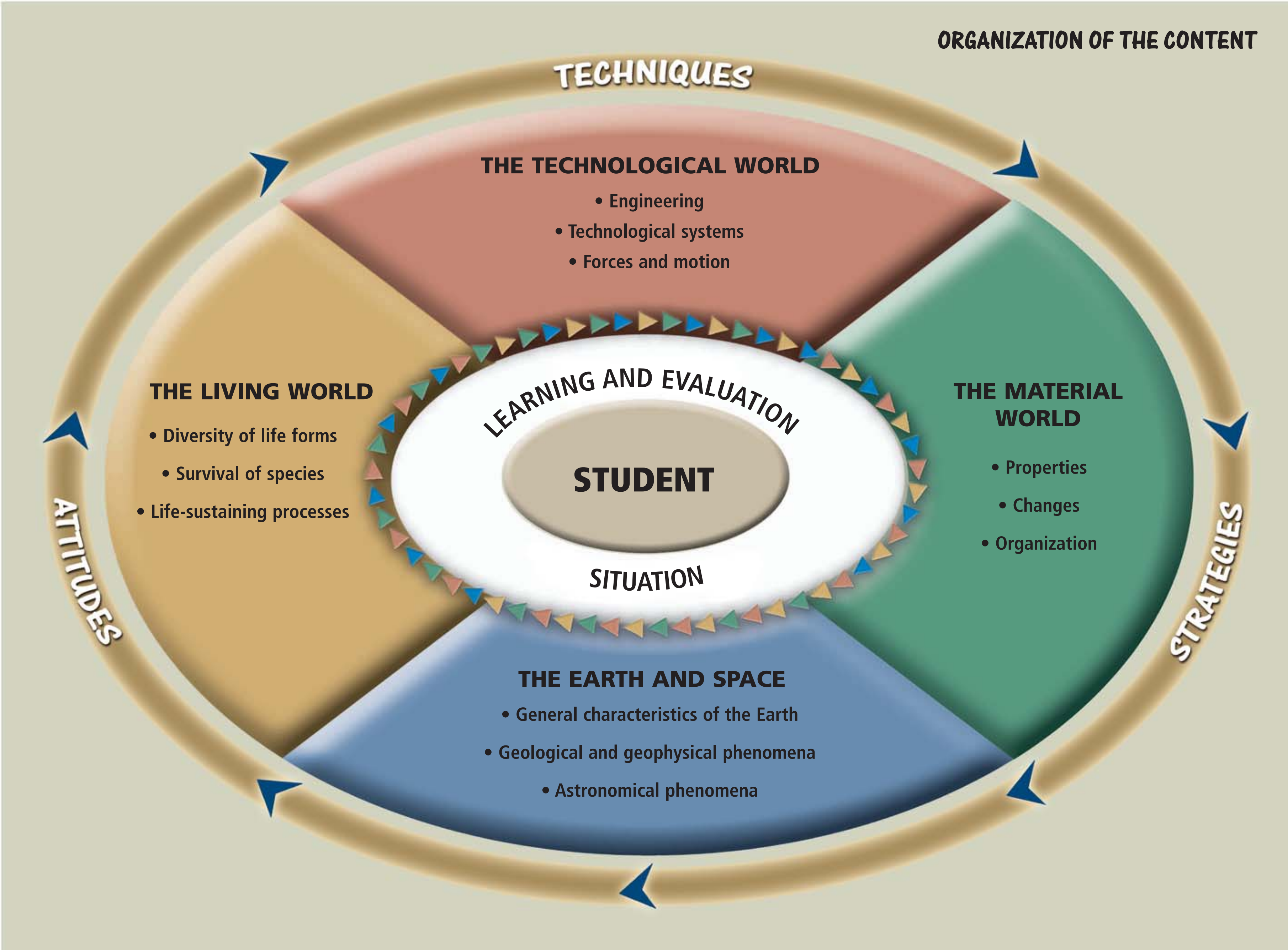
The content of the Science and Technology program for Secondary Cycle One is essential to helping students develop and use the competencies. As was the case at the elementary level, it includes components relating to concepts, strategies, techniques and attitudes that students must use in concrete situations. It differs from the elementary program in that the essential concepts are compulsory, whereas in elementary school, the teacher is encouraged to draw upon a wide range of concepts without being required to cover them all. The program content ensures that starting in Cycle One, students can begin developing a common core of learning consisting of basic concepts in science and technology. This common core of learning should subsequently lead to the acquisition of new concepts that will, in turn, pave the way for the development of the competencies in Cycle Two.

The Science and Technology program for Secondary Cycle One is aimed at developing the students' scientific and technological literacy. This will enable them not only to make use of subject-specific competencies and knowledge in their daily lives, but also to continue studying in this field at the secondary and postsecondary levels if they so wish.

The development of scientific and technological literacy is based on the development of the three competencies targeted in the program. These competencies reflect the way in which students are expected to use their knowledge of science and technology and should enable them to better understand scientific and technological reality in our society as well as the technical objects in their environment. Of course, the development of scientific and technological literacy also involves building a body of knowledge considered essential in Cycle One. Accordingly, the program content encompasses various branches of science and technology (i.e. geology, astronomy, physics, chemistry, biology and different types of technology).

The program content is divided into four major areas based on those outlined in the elementary-level Science and Technology program: *The Material World*, *The Living World*, *The Earth and Space* and *The Technological World*. The program content also includes *strategies, techniques and attitudes* and was organized in this way to make it easier for teachers to identify the key concepts that students should learn. **However, these areas are not compartmentalized but interrelated; they should not be examined separately or sequentially.** The same applies to the concepts, which should not be covered in a predetermined chronological order, but through integrated learning and evaluation situations, as illustrated in the situation outlined in the section entitled *Pedagogical Context*. Teachers are therefore encouraged to draw upon these different areas for the concepts needed to examine a topic or clarify a problem. The concepts selected, along with other resources, will be used to develop the learning and evaluation situations. **An approach recommended for the implementation of the program is to carefully select concepts from these different areas and incorporate them all into a given situation**.

Each of these four major areas is presented in four-column tables. The first column lists general concepts. The second specifies the educational aims associated with the choice of compulsory concepts (i.e. the way in which these concepts should be examined with the students, depending on the targeted level of understanding). Teachers are given some latitude as to how they go about achieving these aims, but minimum requirements must be met in order to provide a solid core of learning throughout the cycle and simplify end-of-cycle evaluation. The third column lists the compulsory concepts for Secondary Cycle One, but teachers should in no way feel bound by this list. The learning and evaluation situations should in fact be designed to enable students to go beyond these minimum requirements. The fourth column lists cultural references that can enrich learning and evaluation situations and contribute to the development of integrated educational activities that reflect the students' social, cultural or everyday reality. These cultural references make it possible to establish connections with the broad areas of learning. In addition to the four major areas discussed above, there are a series of strategies, techniques and attitudes that, each in their own way, foster the development of the competencies in science and technology.


ORGANIZATION OF THE CONTENT
TECHNIQUES
THE TECHNOLOGICAL WORLD
• Engineering
• Technological systems
• Forces and motion
THE LIVING WORLD
• Diversity of life forms
• Survival of species
• Life-sustaining processes
LEARNING AND EVALUATION
STUDENT
SITUATION
THE MATERIAL WORLD
• Properties
• Changes
• Organization
ATTITUDES
STRATEGIES
THE EARTH AND SPACE
• General characteristics of the Earth
• Geological and geophysical phenomena
• Astronomical phenomena

# The Material World

Knowledge of the material world enables students to take a different view of the matter found in their environment. In studying the properties of matter, the changes it undergoes and its organization, students can also consider a variety of useful applications or processes.

| General Concepts | Orientations | Compulsory Concepts | Possible Cultural References |
|---|---|---|---|
| ***Properties*** | A wide variety of substances and materials can be found in the world around us. Whether they are natural or synthetic, they are distinguished from one another by their characteristic properties. These properties often determine how they can be used and the problems they may cause.<br><br>However, other properties, such as mass or volume, cannot be used to identify a substance, a group of substances or a material. These properties are also fundamental for the development of knowledge in science and technology, since they often come into play in activities involving measurement or the formulation of laws.<br><br>In general, properties can be used to describe substances and are the basis for the explanation of certain phenomena. | • Characteristic properties<br>• Mass<br>• Volume<br>• Temperature<br>• States of matter<br>• Acidity/alkalinity | *Environment*<br>• Climate adaptation technology<br>• Water pollution<br>• Wastewater treatment<br>• Drinking water<br>• Waste management<br>• Acid rain<br><br>*History*<br>• Evolution of measuring instruments<br>• History of the discovery of new substances |
| ***Changes*** | Influenced by certain factors, substances and materials undergo changes. Some of these changes occur naturally, but it is also possible to affect these changes. It is essential to understand the nature of these changes, since they have positive as well as undesirable or harmful effects.<br><br>Changes are "chemical" or "physical" depending on whether or not they alter the molecules involved. Regardless of the type of change in question, the total mass of matter and the number of atoms in each element are conserved. | • Physical change<br>• Chemical change<br>• Conservation of matter<br>• Mixtures<br>• Solutions<br>• Separation of mixtures | *Environment*<br>• Chemical and thermal pollution<br>• Recycling<br>• Conservation and restoration of buildings, etc.<br>• Exploitation of hydrocarbons<br><br>*Human Intervention*<br>• Food processing<br>• Manufacturing of household products<br>• Textiles (dyes and synthetic fibres)<br>• Metallurgy (aluminum smelters)<br><br>*History*<br>• Antoine Laurent de Lavoisier |

| General Concepts | Orientations | Compulsory Concepts | Possible Cultural References |
| --- | --- | --- | --- |
| ***Organization*** | Throughout history, different models about the structure of matter have been put forward to explain its properties and the changes it undergoes.<br><br>In Secondary Cycle One, atoms are viewed as the basis for the organization of matter. The periodic table provides a structured classification of every known element. Under certain conditions and depending on their affinity, atoms combine to form molecules. | • Atom<br>• Element<br>• Periodic table<br>• Molecule | *History*<br>• Democritus and Aristotle<br>• John Dalton<br>• Francis Bacon<br>• Dmitri Ivanovich Mendeleev |

## The Living World

By observing the different life forms in their environment, the students become aware of the incredible diversity of living beings. Each life form is the result of successful adaptive strategies. Students realize that reproduction ensures the survival of species. In addition, they discover that life-sustaining processes are closely linked to cell activity.

| General Concepts | Orientations | Compulsory Concepts | Possible Cultural References |
| --- | --- | --- | --- |
| ***Diversity of life forms*** | Millions of living beings are scattered throughout the globe in various habitats. Their study reveals a multitude of ingenious adaptive strategies and represents a constant source of wonder.<br><br>Over time and through a process of evolution and natural selection, certain characteristics of living things have changed, and new species have appeared. When variations within a given species improve its ability to adapt, these characteristics are favoured and genetically transmitted to succeeding generations.<br><br>Observation of differences and similarities between the various species has made it possible to establish and use a classification system. | • Habitat<br>• Ecological niche<br>• Species<br>• Population<br>• Physical and behavioural adaptation<br>• Evolution<br>• Taxonomy<br>• Genes and chromosomes | *History*<br>• Darwin and Lamarck<br>• Linnaeus<br><br>*Natural and Community Resources*<br>• Wildlife and plant life in Québec<br>• Miguasha Park<br>• Biodôme de Montréal<br>• Zoos<br>• Botanical gardens<br>• Aquariums<br>• Museums of natural history<br><br>*Environment*<br>• International treaties on environmental protection<br>• Management of forest resources<br>• Protected areas<br>• Biogeographic regions of Québec |

| General Concepts | Orientations | Compulsory Concepts | Possible Cultural References |
|---|---|---|---|
| ***Survival of species*** | Among other adaptive strategies, reproduction ensures the survival of species.<br><br>The study of the reproductive function of different species reveals a wide range of original and effective solutions.<br><br>For humanity as a whole, sexuality is not limited to reproduction, and birth control seems to be a matter of collective survival. Most everywhere on Earth, different birth control methods are available to those who wish to use them. | • Asexual and sexual reproduction<br>• Reproductive mechanisms in plants<br>• Reproductive mechanisms in animals<br>• Reproductive organs<br>• Gametes<br>• Fertilization<br>• Pregnancy<br>• Stages of human development<br>• Contraception<br>• Methods of preventing the implantation of the zygote in the uterus<br>• Sexually transmitted diseases | *Human Population*<br>• Decrease in the birth rate<br>• Overpopulation<br><br>*Human Intervention*<br>• Reproductive technology<br>• Cloning<br>• Methods of contraception<br>• Horticulture<br>• Agriculture<br><br>*Natural and Community Resources*<br>• Nature interpretation centres<br>• Hunting and fishing seasons |
| ***Life-sustaining processes*** | In Secondary Cycle One, the cell is regarded as the basic structural and functional unit of life.<br><br>Despite the astonishing variety of cellular forms, cells ensure similar vital functions.<br><br>The vital functions are essential for sustaining life. | • Characteristics of living things<br>• Plant and animal cells<br>• Photosynthesis and respiration<br>• Cellular components visible under a microscope<br>• Inputs and outputs (energy, nutrients, waste)<br>• Osmosis and diffusion | *History*<br>• Discovery of the microscope<br>• History of vaccination<br><br>*Physical and Mental Health*<br>• Drugs and poisons<br><br>*Human Intervention*<br>• Genetically modified organisms |

## The Earth and Space

Knowledge of the Earth and space makes students aware of the remarkable variety that characterizes the structure and composition of the planet. The Earth is presented as a complex and dynamic entity, and its study enables students to examine today's major issues from a global perspective. In addition, by studying the position of the Earth in space, students are able to understand certain astronomical and terrestrial phenomena resulting from this position.

| General Concepts | Orientations | Compulsory Concepts | Possible Cultural References |
|---|---|---|---|
| ***General characteristics of the Earth*** | Planet Earth is not a homogeneous and monolithic entity. In fact, its structure can be analyzed and studied. The composition and structure of the Earth vary considerably from its centre to the highest reaches of its atmosphere. The study of its surface also reveals significant differences. All these specific features inevitably affect the beings that live in the biosphere.<br><br>By observing, analyzing and modelling our planet, we have been able to determine our responsibility with regard to some of the changes we have observed. The study of these changes should now convince us that we must work together to make sure we have a healthy planet. | • Internal structure of the Earth<br>• Lithosphere<br>• Hydrosphere<br>• Atmosphere<br>• Types of rocks (basic minerals)<br>• Atmospheric layers<br>• Water (distribution)<br>• Air (composition)<br>• Types of soil<br>• Relief | *Environment*<br>• Water as a resource (e.g. St. Lawrence, lakes and rivers in Québec, Great Lakes)<br>• Québec's natural resources (mines, forests)<br>• Climate change<br>• Deforestation<br>• Erosion of agricultural land |
| ***Geological and geophysical phenomena*** | The Earth is a fascinatingly complex entity. Although hardly noticeable to human beings, the internal dynamics of the planet are at the origin of several noteworthy geological phenomena.<br><br>On Earth, there are many natural energy sources that mostly emanate from the Sun and that can be harnessed by humans. | • Tectonic plate<br>• Volcano<br>• Earthquake<br>• Orogenesis<br>• Erosion<br>• Natural energy sources<br>• Winds<br>• Water cycle<br>• Renewable and nonrenewable energy resources | *Human Intervention*<br>• Exploitation of Québec's energy resources<br><br>*Events*<br>• Ice storm<br>• Saguenay Flood<br><br>*Geography*<br>• Appalachians<br>• Geological regions and topography of Québec |

| General Concepts | Orientations | Compulsory Concepts | Possible Cultural References |
|---|---|---|---|
| ***Astronomical phenomena*** | Although it looks virtually static at first glance, the sky is the scene of some remarkable activity. This activity is governed by Universal Gravitation between all celestial bodies, which regulates their motion and determines the structure of the solar system.<br><br>The study of this motion and of the properties of light makes it possible to explain many phenomena that can be observed from the Earth, such as the cycles of day and night, the phases of the moon, eclipses, the seasons, and comets.<br><br>The study of the solar system also makes it possible to identify certain conditions essential to the appearance and preservation of life. | • Universal Gravitation (qualitative study)<br>• Solar system<br>• Light (properties)<br>• Cycles of day and night<br>• Phases of the moon<br>• Eclipses<br>• Seasons<br>• Comets<br>• Aurora borealis (northern lights)<br>• Meteoroid impact | *Natural and Community Resources*<br>• Astronomical observatories<br>• Planetarium<br>*Events*<br>• Manicouagan craters<br>• Charlevoix astrobleme<br>*Human Intervention*<br>• Canadian Space Program<br>• Man-made satellites<br>• International Space Station<br>*History*<br>• Time zones<br>• Calendar<br>• History of space flight<br>• Conquest of space<br>• Extinction of the dinosaurs |

## The Technological World

By becoming familiar with the world of technology, the students come to realize that technology is an integral part of the world around them. The study of engineering concepts is aimed at providing them with tools for designing and making the prototype of a technical object. By studying mechanisms in terms of forces, motion or energy transformations, the students can understand how certain technological systems work.

| General Concepts | Orientations | Compulsory Concepts | Possible Cultural References |
|---|---|---|---|
| ***Engineering*** | Technology has always been a part of all human cultures. The first objects made were simple, yet ingeniously designed. Over time, their structure became more complex and involved a greater number of interacting parts.<br><br>As a result, it became necessary to devise new methods of recording or representing the important elements in a design, manufacturing or analytical process.<br><br>The discovery of new types of materials or new properties made it possible to design and make new technical objects in different fields of activity. | • Specifications<br>• Design plan<br>• Technical drawing<br>• Manufacturing process sheet<br>• Raw material<br>• Material<br>• Equipment | *History*<br>• Evolution of building materials<br>• Workplace automation<br>• History of the evolution of machines and tools<br>• Inventions<br>• Denis Papin<br>• Joseph-Armand Bombardier |

| General Concepts | Orientations | Compulsory Concepts | Possible Cultural References |
|---|---|---|---|
| ***Engineering* (*cont.*)** | | | *History* (*cont.*)<br>• Alexander Graham Bell<br>• Reginald Fessenden<br>*Economy*<br>• Canadian Intellectual Property Office (CIPO) |
| ***Technological systems*** | Different systems are used everyday to increase our comfort, satisfy our needs or make our work easier.<br>A system is a combination of interacting or interdependent components that form a unified whole.<br>In order to function, all systems require inputs and must produce outputs in the form of materials or energy.<br>The study of technological systems provides a good opportunity to observe concrete examples of energy and energy transformations and to design systems with sustainable development in mind. | • System (overall function, inputs, processes, outputs, control)<br>• Components of a system<br>• Basic mechanical functions (links, guiding control)<br>• Energy transformations | *Human Intervention*<br>• Household appliances<br>• Home heating system<br>• Residential electrical system<br>• Residential plumbing system<br>*Production and Transportation of Energy*<br>• Energy production systems (dam, thermal power plant, wind power plant)<br>• Waterworks, gas and oil pipelines |
| ***Forces and motion*** | The analysis of technical objects reveals concrete examples of forces and motion. Forces acting on the parts of a mechanism can change their motion and impose mechanical stress that may deform or break them.<br>The application of the concept of force enables students to better understand simple machines and their uses.<br>The study of forces and motion also makes it possible to understand mechanisms that transmit motion (e.g. gears, pulleys, endless screw) and those that bring about a change in motion (e.g. cams, connecting rods). | • Types of motion<br>• Effects of a force<br>• Simple machines<br>• Mechanisms that transmit motion<br>• Mechanisms that bring about a change in motion | *Transportation*<br>• Bridges<br>• Aviation and aerospace science<br>• Transportation technology<br>• Bicycle, sailboard or skateboard<br>*History*<br>• Industrial revolution |

# Strategies, Techniques and Attitudes

## Strategies

Scientific and technological strategies can be used to implement a problem-solving procedure, explore and study the elements of a situation, and exchange information. They are therefore useful for developing the competencies and doing well-organized scientific and technological work. These strategies have been divided into three categories.

### Exploration Strategies

- Dividing a complex problem into simpler subproblems
- Identifying the constraints and elements that must be taken into account to solve the problem
- Using different types of reasoning (e.g. inductive and deductive reasoning, inference, comparison, classification)
- Exploring various ways of solving the problem
- Predicting the results of the procedure used
- Ensuring that the procedure is appropriate and safe and making the necessary adjustments
- Recalling similar problems that have already been solved
- Examining errors in order to identify their source

### Instrumentation Strategies

- Using different tools for recording information (e.g. diagrams, notes, graphs, procedures, logbook)
- Selecting suitable techniques or tools for observation

### Communication Strategies

- Using tools to display information in various formats: data tables, graphs or diagrams)
- Using various means of communication (e.g. oral presentation, written presentation, Web page)

## Techniques

Many scientific and technological activities can be carried out smoothly by using a number of suitable techniques, which involve methodical procedures that provide guidelines for the proper application of theoretical knowledge. These work procedures, which are used in learning and evaluation situations, are divided into two major categories.

### Technology

**Graphic communication**

Techniques for:

- Doing a technical drawing
- Reading plans
- Drawing schematic diagrams
- Using scales
- Using drawing instruments

**Manufacturing**

Techniques for:

- Measuring and laying-out
- Machining and forming
- Finishing
- Assembling
- Assembling and dismantling

### Science

Techniques for:

- Separating mixtures
- Using laboratory materials and equipment safely
- Using measuring instruments
- Using observational instruments
- Designing and creating an environment (e.g. terrariums, aquariums, composting environments)

## Attitudes

One of the goals of the Science and Technology program is the promotion of attitudes that make it easier for students to engage in scientific and technological processes and that help them develop a sense of responsibility for their own actions and with respect to society at large. Attitudes are an important factor in the development of the competencies.

These attitudes can be divided into two categories. First, attitudes of openness make students receptive to various types of knowledge as well as every possible perspective or approach that can be encountered in science and technology. Secondly, attitudes of rigour, which provide guidelines for students' behaviour, are required to ensure that scientific and technological activities are carried out smoothly. These two types of attitudes complement each other and are inextricably linked.

### Attitudes of Openness

- Curiosity
- Attentiveness
- Sense of initiative
- An inclination to take intellectual risks
- Team spirit
- Interest in comparing their ideas with the ideas of those around them
- Receptive to original solutions and appropriate answers
- International solidarity in dealing with major issues

### Attitudes of Rigour

- Personal discipline
- Intellectual rigour
- Objectivity
- Independence
- Perseverance
- Methodical approach to one's work
- Concern for a job well done
- Sense of responsibility
- Willingness to work hard
- Willingness to cooperate effectively with others
- Concern about using proper language and correct terminology
- Concern for health and safety
- Respect for life and the environment

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