a WOW Lab BLUEPRINT Wind Power

Quebec - Achievements and Competencies

Learning Outcomes

Cycle 1 (Gr. 7-8)	Cycle 2 (Gr. 9-10)
Geological and geophysical phenomena	Geological and geophysical phenomena
Forces and motion	Electricity
Transformations of energy	Electromagnetism
	Transformations of energy

The Quebec Achievements and Competencies are based on the Progression of Learning Outcomes derived from the Quebec Education Plan set by the Ministere de l'Education, du Loisir et du Sport.

Specific Expectations

GENERAL EDUCATION PATH

CYCLE 1 (Gr. 7-8) — Secondary 1 and 2

EARTH AND SPACE

B. Geological and geophysical phenomena
  f. Winds
    i) Names the main factors responsible for wind (e.g. convection movements, movement of air masses)

In *Wind Power*, students will build a windmill in order to learn how it can be used to produce electricity and to discuss the advantages and disadvantages of harnessing wind power. There are many scientific concepts addressed in this activity, including wind, energy, and electricity. Students discuss what wind is and the factors that influence it.

  i. Renewable and nonrenewable energy resources
    i) Distinguishes between renewable and nonrenewable energy resources (e.g. Sun, molten rock, moving water, oil)

Students recognize that windmills produce electricity by converting the kinetic energy from the wind into electricity. This is considered a renewable energy source since wind is a natural resource and can be replenished.

a WOW Lab

BLUEPRINT

Wind Power - Quebec - Achievements and Competencies

TECHNOLOGICAL WORLD

B. Mechanical engineering
  1. Force and motion
    a. Types of motion
      i) Identifies parts that move in a specific way in a technical object (rectilinear translation, rotation, helical)
    b. Effects of a force
      i) Explains the effects of a force in a technical object (change in the motion of an object, distortion of a material)

In this activity, students will identify that the wind causes the blades of the turbine to move in a rotational manner. This rotation of the blades then causes the shaft of the generator to spin, which then produces an electric current. The students should make the connection that it is the force of the wind on the blades that, in the end, is necessary to produce electricity.

  2. Technological systems
    c. Energy transformations
      i) Associates energy with radiation, heat or motion
      ii) Defines energy transformations
      iii) Identifies energy transformations in a technical object or technological system

Students will learn about energy transformations throughout this activity. As they learn about windmills and wind power, they will learn how the kinetic energy from the wind is converted into mechanical energy, which is then converted into electrical energy.

CYCLE 2 (Gr. 9-10) — Secondary 4

EARTH AND SPACE

B. Geological and geophysical phenomena
  i. Renewable and nonrenewable energy resources
    i) Distinguishes between renewable and nonrenewable energy resources (e.g. Sun, molten rock, moving water, oil)
    ii) Describes technologies used to produce electricity using the energy resources in the lithosphere, hydrosphere and atmosphere
    iii) Describes the main impact of the use of energy resources in the lithosphere, hydrosphere and atmosphere

In *Wind Power*, students examine how a windmill is used to convert kinetic energy into electricity. They should describe what occurs in order for this transformation of energy to happen. Students should identify the impacts of wind power, discussing both its advantages and disadvantages. They will understand that this type of energy production is renewable, because it uses the wind, which is a natural resource.

a WOW Lab

BLUEPRINT

Wind Power - Quebec - Achievements and Competencies

MATERIAL WORLD

F. Electricity and Electromagnetism
  1. Electricity
    d. Electrical circuits
      i) Describes the function of different elements of an electrical circuit (e.g. the wires transmit electrons along the circuit, resistors transform electrical energy into another form of energy)
      ii) Describes the two types of connections in electrical circuits (series, parallel)

In *Wind Power*, students will learn how the windmill is used to produce electricity. They will come to understand that the blades of the windmill turn a shaft which is connected to a generator. The generator is the device that produces electricity. When the students' pop bottle windmills are used to create the class wind farm, they can describe and compare series and parallel circuits. Students should realize that the way in which the windmill generators are connected to one another (series or parallel) will alter the voltage and electric current output of the farm. Teachers can refer to the *Additional Information - Pop Bottle Windmills* document for more information to share with students on series and parallel circuits.

  2. Electromagnetism
    a. Magnetic field of a live wire
      i) Describes the magnetic field produced by a current-carrying wire (right-hand rule or left-hand rule)
      ii) Names ways of modifying the intensity of the magnetic field produced by a current-carrying wire (type of wire, current intensity)

Students will learn how a generator works to produce electricity. An electromagnetic field is produced when the kinetic wind energy is converted into electrical energy by the generator. Teachers can refer to the *Additional Information - Pop Bottle Windmills* document for a simple demonstration for students to teach them about electrical generators and how they work.

TECHNOLOGICAL WORLD

C. Electrical engineering
  a. Power supply
    i) Defines power supply as the ability to generate electrical current
    ii) Determines the source of current in technical objects with an electrical circuit (e.g. chemical battery, solar cell, alternator, thermocouple, piezoelectric)

Students will define the term 'power supply' and identify that the generator in the windmill is responsible for converting the kinetic wind energy into electricity.

  d. Transformation of energy (electricity and light, heat, vibration, magnetism)
    i) Associates the transformation of energy with different components of a circuit (e.g. bulbs transform electrical energy into light and heat)

Students will learn about energy transformations throughout this activity. As they learn about windmills and wind power, they will learn how the kinetic energy from the wind is converted into mechanical energy, which is then converted into electrical energy.

a WOW Lab

BLUEPRINT

Wind Power - Quebec - Achievements and Competencies

CYCLE 2 (Gr. 9-10) — EST Secondary 4

MATERIAL WORLD

F. Electricity and Electromagnetism
  1. Electricity
    f. Kirchhoff's laws
      i) Describes the distribution of current in various components of an electrical circuit
      ii) Determines the value of the current flowing in various components of a series or parallel circuit
      iii) Describes the distribution of the voltage across various components of an electrical circuit
      iv) Determines the value of the voltage across various components of a series or parallel circuit

In *Wind Power*, students will build pop-bottle windmills in groups. Once completed, a class wind farm will be created. Students should engage in discussion regarding the distribution and value of voltage and current in both series and parallel circuits. Students will recognize that the way in which the windmill generators are connected to one another will alter the voltage and current output of the farm.

  2. Electromagnetism
    c. Magnetic field of a solenoid
      i) Describes the magnetic field produced by a solenoid (right-hand rule or left-hand rule)
      ii) Names ways of changing the intensity of the magnetic field produced by a solenoid (nature of the core, intensity of the current, number of turns)
      iii) Explains the use of solenoids in technological applications (e.g. earphones, electric motor, magnetic crane)

Students will learn how the generator produces an electromagnetic field and an electric current. When the solenoid (cylindrical coil of wire) in the generator turns, it produces an electromagnetic field which generates electrical energy. Student can discuss how the energy output of the windmill could be improved. They should think about how modifications in blade size, height, and location might affect the production of energy.

TECHNOLOGICAL WORLD

C. Electrical engineering
  e. Other functions
    i) Describes the function of certain electronic components (condenser, diode)

Students should describe how the generator creates electricity. They should be able to explain how each part of the windmill functions to allow for the production of electricity.

a WOW Lab

BLUEPRINT

Wind Power - Quebec - Achievements and Competencies

APPLIED GENERAL EDUCATION PATH

CYCLE 1 (Gr. 7-8) — Secondary 1 and 2

EARTH AND SPACE

B. Geological and geophysical phenomena
- f. Winds
  - i) Names the main factors responsible for wind (e.g. convection movements, movement of air masses)

In *Wind Power*, students will be given the opportunity to build a windmill in order to understand how it produces electricity and to discuss the advantages and disadvantages of wind power. There are many scientific concepts addressed in this activity, including wind, energy, and electricity. Students will discuss what wind is and the factors that influence it.

- i. Renewable and nonrenewable energy resources
  - i) Distinguishes between renewable and nonrenewable energy resources (e.g. Sun, molten rock, moving water, oil)

Students recognize that windmills produce electricity by converting the kinetic energy from the wind into electricity. This is considered a renewable energy source because wind is a natural resource and can be replenished.

TECHNOLOGICAL WORLD

B. Mechanical engineering
1. Force and motion
   - a. Types of motion
     - i) Identifies parts that move in a specific way in a technical object (rectilinear translation, rotation, helical)
   - b. Effects of a force
     - i) Explains the effects of a force in a technical object (change in the motion of an object, distortion of a material)

In this activity, students will identify that the wind causes the blades of the turbine to move in a rotational manner. This rotation of the blades then causes the shaft of the generator to spin, which then produces an electric current. The students should make the connection that it is the force of the wind on the blades that, in the end, is necessary to produce electricity.

2. Technological systems
   - c. Energy transformations
     - i) Associates energy with radiation, heat or motion
     - ii) Defines energy transformations
     - iii) Identifies energy transformations in a technical object or technological system

Students will learn about energy transformations throughout this activity. As they learn about windmills and wind power, they will learn how the kinetic energy from the wind is converted into mechanical energy, which is then converted into electrical energy.

C. Electrical engineering
  a. Power supply
    i) Defines power supply as the ability to generate electrical current
    ii) Determines the source of current in technical objects with an electrical circuit (e.g. chemical battery, solar cell, alternator, thermocouple, piezoelectric)

Students will define the term 'power supply' and identify that the generator in the windmill is responsible for converting the kinetic wind energy into electricity.

CYCLE 2 (Gr. 9-10) — Secondary 4

EARTH AND SPACE

B. Geological and geophysical phenomena
  i. Renewable and nonrenewable energy resources
    i) Distinguishes between renewable and nonrenewable energy resources (e.g. Sun, molten rock, moving water, oil)
    ii) Describes technologies used to produce electricity using the energy resources in the lithosphere, hydrosphere and atmosphere
    iii) Describes the main impact of the use of energy resources in the lithosphere, hydrosphere and atmosphere

In *Wind Power*, students examine how a windmill is used to convert kinetic energy into electricity. They should describe what occurs in order for this transformation of energy to happen. Students should identify the impacts of wind power, discussing both its advantages and disadvantages. They will understand that this type of energy production is renewable, because it uses the wind, which is a natural resource.

MATERIAL WORLD

F. Electricity and Electromagnetism
  1. Electricity
    d. Electrical circuits
      i) Describes the function of different elements of an electrical circuit (e.g. the wires transmit electrons along the circuit, resistors transform electrical energy into another form of energy)
      ii) Describes the two types of connections in electrical circuits (series, parallel)

In *Wind Power*, students will learn how the windmill produces electricity. They will come to understand that the blades of the windmill turn a shaft which is connected to a generator. The generator is the device that produces electricity. When the students' windmills are used to create the class wind farm, they can describe and compare series and parallel circuits. Students should realize that the way in which the windmill generators are connected to one another (series or parallel) will alter the voltage and electric current output of the farm. Teacher can refer to the *Additional Information - Pop Bottle Windmills* document for more information to share with students on series and parallel circuits.

2. Electromagnetism
   c. Magnetic field of a solenoid
      i) Describes the magnetic field produced by a solenoid (right-hand rule or left-hand rule)
      ii) Names ways of changing the intensity of the magnetic field produced by a solenoid (nature of the core, intensity of the current, number of turns)
      iii) Explains the use of solenoids in technological applications (e.g. earphones, electric motor, magnetic crane)

Students will learn how the generator produces an electromagnetic field and an electric current. When the solenoid (cylindrical coil of wire) in the generator turns, it produces an electromagnetic field which generates electrical energy. Students can discuss how to change the energy production of the windmills, comparing the size of the blades of the turbine and their affects on the production of electricity.

TECHNOLOGICAL WORLD

C. Electrical engineering
   d. Transformation of energy (electricity and light, heat, vibration, magnetism)
      i) Associates the transformation of energy with different components of a circuit (e.g. bulbs transform electrical energy into light and heat)

Students will learn about energy transformations throughout this activity. As they learn about windmills and wind power, they will learn how the kinetic energy from the wind is converted into mechanical energy, which is then converted into electrical energy.

   e. Other functions
      i) Describes the function of certain electronic components (condenser, diode)

Students should describe how the generator works to create electricity. They should be able to explain how each part of the windmill functions to allow for the production of electricity.

Techniques

A. Technology
   2. Manufacturing
      f. Assembling and disassembling
         i) Identifies and gathers the parts and hardware
         ii) Chooses the appropriate tools
         iv) In the case of electrical circuits, identifies and gathers the electrical components
         viii) Connects the components using wire, connectors or solders

a WOW Lab

BLUEPRINT

Wind Power - Quebec - Achievements and Competencies

Strategies

A. EXPLORATION STRATEGIES

1. Studying a problem or a phenomenon from different points of view (e.g. social, environmental, historical, economic)
2. Distinguishing between the different types of information useful for solving the problem
3. Referring to similar problems that have already been solved
4. Becoming aware of his or her previous representations
6. Formulating questions
7. Putting forward hypotheses (e.g. individually, in teams, as a class)
8. Exploring various ways of solving the problem
9. Anticipating the results of his or her approach
10. Imagining solutions to a problem in light of his or her explanations
11. Taking into account the constraints involved in solving a problem or making an object (e.g. specifications, available resources, time allotted)
12. Examining his or her mistakes in order to identify their source
13. Using different types of reasoning (e.g. induction, deduction, inference, comparison, classification)
14. Using empirical approaches (e.g. trial and error, analysis, exploration using one's senses)
15. Ensuring that the procedure is appropriate and safe and making the necessary adjustments
16. Collecting as much scientific, technological and contextual information as possible to define a problem or predict patterns
19. Considering various points of view on scientific or technological issues

B. INSTRUMENTATION STRATEGIES

1. Using different sources of information (e.g. books, newspapers, Web sites, magazines, experts)
2. Validating sources of information
4. Using different tools for recording information (e.g. diagrams, notes, graphs, procedures, logbook)
5. Using a variety of observational techniques and tools

C. ANALYTICAL STRATEGIES

1. Identifying the constraints and important elements related to the problem-solving situation
2. Dividing a complex problem into simpler subproblems
3. Using different types of reasoning (e.g. inductive and deductive reasoning, comparison, classification, prioritization) in order to process information
4. Reasoning by analogy in order to process information and adapt scientific and technological knowledge
5. Selecting relevant criteria to help him or her determine where he or she stands on a scientific or technological issue

D. COMMUNICATION STRATEGIES

3. Exchanging information
4. Comparing different possible explanations for or solutions to a problem in order to asses their relevance (e.g. full-group discussion)
5. Using tools to display information in various formats (e.g. data tables, graphs, diagrams)