

Task 1. A Case Study of the Environmental Impacts of Transportation Choices

Background: Solid waste (garbage) is often stored in landfill sites or incinerated. With the closure of the local landfill, Toronto's garbage is transported by truck to Michigan. Trucks transport solid waste from Toronto to Michigan, driving along Highway 401, traveling through areas with sensitive ecosystems or different land uses. People living near these areas are concerned about how this transportation choice affects them.

Scenario: Various people (farmer, transport company employee, reporter, municipal councillor, environmental activist) in the Toronto area have been asked to create a proposal that will reduce the environmental impacts of transporting waste.

Student Task: Students will complete an Environmental Impact Form. Then, students will choose (or be assigned) one of the following roles: farmer, transport company employee, reporter, municipal councillor, environmental activist. Using this assumed perspective, they will recommend a proposal for action for a strategy to reduce the environmental impacts of transporting waste. They will create a flyer to act as a cover page that could be sent to members of city council, lobbying for a strategy that will:

- ▶ support their position;
- ▶ describe the effects on a specific ecosystem;
- ▶ describe the effects on the global climate and support the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

Resources

Student worksheets have been developed to support this task:

- ▶ Appendix 1.1 *Checklist of Preparation - A Case Study of the Impact of Transportation Choices* helps the students keep track of the information and skills they need to prepare for the assignment.
- ▶ Appendix 1.2 *Summary of the Kyoto Protocol* provides an overview of the Protocol and its goals.
- ▶ Appendix 1.3 *Student Task: A Case Study of the Impact of Transportation Choices* outlines the task and identifies the expectations covered.
- ▶ Appendix 1.4 *Environmental Impact Form* organizes the students' work to help ensure that they have all the information necessary to complete the task.

Teacher resources include:

- ▶ Strand-by-strand Focus Questions are supplied to help organize ideas and lessons to support the task.
- ▶ Appendix 1.5 *Evaluation Rubric for Environmental Impact Form*
- ▶ Appendix 1.6 *Evaluation Rubric for Flyer*

Expectations

[Note: examples in square brackets are additions tailored for this resource.]

BY1.05D	examine how abiotic factors affect the survival and geographical location of biotic communities	ES1.02D	describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks [how do changes in local heat production affect local weather through the water cycle]
BY3.01D	assess the impact of technological change and natural change on an ecosystem	ES1.03D	describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents
BY3.05D	identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, MNR]	ES2.06D	investigate factors which affect the development, severity, and movement of global and local weather systems [Are global systems causing changes? What are predicted rates?]
CH1.04D	describe and explain qualitatively how factors such as energy, concentration, and surface area can affect rates of chemical reactions	PHV.03D	analyse everyday phenomena and technologies in terms of the motions involved [e.g., consider alternate transport systems]
CH2.08D	represent simple chemical reactions using molecular models, word equations, and balanced chemical equations (to show how new compounds are formed)	BY2.03D	select and integrate information from various sources, including electronic and print resources, community resources, and personally collected data, to answer the questions chosen
CH3.01D	explain how environmental challenges can be addressed through an understanding of chemical substances [e.g., reducing the production of CO ₂ using effective technologies]	BY2.04D	analyse data and information and evaluate evidence and sources of information, identifying flaws such as errors and bias
		PH3.03D	analyse how technology is used for tracking the motion of objects and outline the kinds of scientific knowledge gained through the use of such technologies

Prior Learning Required for this Task

The task requires that the student have a basic understanding of one of the main goals of the Kyoto Protocol which Canada has ratified – to reduce greenhouse gas emissions (to 6% below 1990 levels by the 2008-2012 period). This is the context within which the research, analysis and application is pursued. See Appendix 1.2 for a one-page student summary of the Kyoto Protocol

*The Ontario EcoSchools multimedia presentation *The Science of Climate Change* has been designed specifically for Grade 10 Science (see Resources for ordering information).*

Fundamental Skills

▸ *Read and Analyse*

Students need to be able to read material and identify/classify key ideas:

Problem

Processes

Factors

Effects

Concept mapping activities or other graphic organizers that help them find and classify information would provide practice.

▸ *Research*

Students need to be able to find information on the ecosystem of interest. This may include map-reading skills. From this material, students need to identify biotic and abiotic factors. Activities that support this learning require students to find data and interpret data. *As students learn about ecosystems they should work with the same text and electronic resources that will be available for the summative task.*

▸ *Systems Analysis*

Students need to be able to identify parts of a system and connections between or among systems. In particular, students need to be able to identify relevant outputs from human systems that act as inputs into one or more other (natural or social) systems.

Science Background

▶ *Biology: The Sustainability of Ecosystems*

Textbooks often present a generic ecosystem for describing the parts and processes of such a system. Students need to identify specific elements in a specific ecosystem to complete the summative task effectively.

▶ *Chemistry: Chemical Processes*

Truck exhaust is a source of heat, acid and GHG. The diversity of these emissions must be addressed during the learning of the course so that they can apply this knowledge to the summative task. Students may want to find out how many trucks leave the city each day and what the specific output of each truck is.

▶ *Earth and Space Science: Weather Dynamics*

Textbooks often present generic weather information. Students need to be familiar with how to find normal weather patterns for a region that contains an ecosystem of interest. This means that they need to consider the abiotic factors of an ecosystem in terms of weather events, such as rain, flood, drought, snow, ice, etc.

▶ *Physics: Motion*

Students must have some experience working with maps that describe transportation routes. This should include interpreting how many lanes wide a highway is at different stretches, and any differences in maximum speed. Ideally, students will have some experience comparing the effectiveness of different transportation systems such as gas-powered trucks, diesel trucks and trains.

Focus Questions – Connections to Climate Change

These strand-by-strand questions are provided to suggest ways to organize ideas as you plan your lessons with the culminating task in mind.

Biology: The Sustainability of Ecosystems

Focus Questions

- How is the carbon cycle related to climate change?
- What are the consequences of changing the carbon balance?
- How does the production of CO₂ affect the carbon cycle?
- How does CO₂ change the amount of heat in the atmosphere?
- How does increased heat affect the carbon cycle?
- How much CO₂ makes a difference?
- What are the consequences of CO₂ changes for ecosystems?
- How is pH linked to changes in the atmosphere and ecosystems?
- How can production of CO₂ be measured?
- What new technologies can monitor and reduce carbon production?
- What kinds of transportation would help meet the targets of the Kyoto Protocol?
- How do governments in Canada support sustainable practices?

Climate Change Connections

- ▶ Any model of the carbon cycle for an ecosystem can act as a model for a carbon budget for the planet. This accounting framework measures carbon stocks and fluxes (inputs and outputs) that identify carbon sources and sinks. A balance of sources and sinks means that global levels remain the same. Activity that disturbs this balance can then be identified.
- ▶ Heat is an important abiotic factor that helps relate the specific details of an ecosystem to the macrocosm of the planet. Increased energy in the atmosphere affects both wind and water patterns, which in turn affect weather and climate patterns.
- ▶ Explicitly consider the Kyoto Protocol in terms of technology use and development. Canadian initiatives include technology development, especially the development of “green” technology that has a small ecological footprint, and a system of national parks that protects ecosystems. Government policy and support for “green” technology and national parks can be explored and assessed.
- ▶ The belief in the need for sustainable activity underlies some policy choices and technological innovation. As more people are affected by the consequences of change, they begin to understand the need for more sustainable practices.

Chemistry: Chemical Processes

Focus Questions

What are some of the chemical products of some human processes such as incineration or vehicle emission?

How can the products of one chemical reaction affect the reactions of other substances in the environment?

What are some of the greenhouse gases (GHGs)?

How do GHGs affect the environment?

How do we assess the environmental impact of a chemical process?

How is the chemical nature of the atmosphere changed with the addition of some of the wastes of human processes?

What is the impact of different concentrations of substances on the environment and other chemical reactions?

How can CO₂ be detected or measured?

How can the products of chemical processes be reused or recovered to limit their impact on the environment?

Climate Change Connections

- ▶ Many industrial and technological processes have a chemical impact on the environment. Reactions of interest should include combustion of carbon compounds to form greenhouse gases, and the products of oxidized metal, which can result from increased air pollution.
- ▶ The concentration of greenhouse gases changes the impact of these gases on ecosystems and global climate patterns.
- ▶ Use specific greenhouse gases and other carbon compounds to reinforce students' understanding of the different components of the carbon cycle.
- ▶ Simple chemical formulae help explain the changes that take place in the small system of a chemical reaction. The products may then participate with other substances, including substances in the surrounding environment.
- ▶ Products formed by the combustion of organic compounds such as oil, wood or natural gas are released into the environment.
- ▶ Carbon dioxide is the product of many reactions. Finding a test to determine the presence of carbon dioxide has allowed us to monitor the level of these emissions in the atmosphere. This is an example of why it is important to be able to assess the impact of chemical processes on the environment.
- ▶ Strategies to reduce emissions already exist that involve the addition of new parts (catalytic converter on cars or scrubbers on industrial smokestacks) to a system to change the output to the environment.
- ▶ Different “green” products or choices can be explored. Sometimes products are “green” because an output (water bottle) is added to a new system that cycles the matter (as fleece clothing). Other products are “green” because they are produced through efficient energy means and/or use energy more efficiently.

Earth and Space Science: Weather Dynamics

Focus Questions

What is the global radiation balance?

How does CO₂ concentration in the atmosphere affect the global radiation balance?

What is the flow of energy in the atmosphere and hydrosphere?

How does human activity affect the global radiation balance?

How do changes to the global radiation balance affect us?

What are the potential consequences for climate change?

Climate Change Connections

- ▶ Explain the global radiation balance in terms of energy arriving from the sun and energy leaving the planet to outer space. Then consider how changes to the atmosphere caused by greenhouse gases affect this balance of incoming and outgoing energy. The greenhouse gases absorb outgoing radiation, so less energy leaves the Earth. The solar radiation arriving is almost constant, so the imbalance increases and high levels of energy are retained.
- ▶ With a net change of more energy in the atmosphere, the transfer of energy changes, affecting both trade wind patterns and ocean current patterns. Climate change is a consequence of these energy changes.
- ▶ Heat transfer is studied in terms of changes in the hydrosphere. This is where heat transfer takes place and where the consequences develop.
- ▶ Consider the consequences of shifting wind patterns and current patterns. This is like climate modeling, and allows students to consider possible future scenarios.

Physics: Motion

Focus Questions

How can transportation systems be defined?

What is the environmental impact of different transportation systems?

Why are some transportation systems preferred over other systems?

Climate Change Connections

- ▶ Transportation systems can be defined and compared in terms of energy use and CO₂ production. Compare the stopping and starting of different forms of transportation along a specific path (such as Keele station to Yonge station along Bloor Street).
- ▶ A subway train will start and stop fewer times than an automobile.
- ▶ Fast, flexible transportation has generally required fossil fuels. Cars allow more personal freedom than a train can provide (train may be electric or diesel).

Resources

Textbooks

See “How Approved Textbooks Link to Learning about Climate Change” (pages 39-42) for a strand-by-strand list of climate change topics in Science textbooks.

Websites

Carbon budget

<http://www.climatechangesolutions.com/science/greenhouse/budget.shtml?o=gases&r=budget>

Simple explanation of model with sample values. “One of the easiest ways to understand how and why human activities are changing the global climate is to think of the earth’s atmosphere as a credit card account. The annual statement lists purchases and repayments, and the difference between the two is the increase in the total debt. In the case of carbon dioxide, which is the most important long-lived greenhouse gas (GHG), the statement is referred to as a carbon budget. The purchases made are called emissions, and the repayments made are called ‘sinks’”

<http://geochange.er.usgs.gov/pub/carbon/fs97137/>

This is a very helpful site that puts the idea of the carbon budget in the climate change context, with specific reference to the Mississippi Valley.

Ecosystems

http://www.ec.gc.ca/ecos_e.html

This site from Environment Canada has information about ecosystems across Canada, and in the Great Lakes region.

<http://www.climatehotmap.org/impacts/greatlakes.html>

This is an American site that looks at how human activity has compromised, and continues to compromise, the Great Lakes region.

<http://www.ucsusa.org/greatlakes/>

This excellent site from the Union of Concerned Scientists has links to many PDF files. The focus is to link climate change to ecosystems in the area with an overall view of climate models, extreme weather and actions we can choose.

<http://www.epa.gov/glnpo/ecopage/>

This site has many links that are useful for ecosystem studies.

Vehicle Exhaust

http://www.lungusa.org/air/airout00_diesel.html

This site is simple and points out that diesel exhaust includes many different compounds that affect human health.

<http://www.osha.gov/SLTC/dieselexhaust/chemical.html>

A good list that includes many components of diesel exhaust. Each chemical listed links to a chemical sampling information page.

http://www.planetdrum.org/guard_fox_watch.htm

A site devoted to finding sustainable solutions by developing bioregional activities. This page looks at the environmental impact of transportation routes and vehicular traffic in an environmentally sensitive area (The Winter Olympics in Nagano).

<http://www.nutramed.com/environment/carschemicals.htm>

There are many links on this site. This site identifies health risks from exhaust chemicals.

<http://www.nrdc.org/air/transportation/ebd/chap2.asp>

Good site with health risks outlined and specific chemical products listed.

Weather

http://www.ec.gc.ca/TKEI/cc_weather/s_weather_e.cfm

This site explains what is meant by “severe weather” and uses Canadian examples as illustrations.

<http://www.epa.gov/glnpo/atlas/glat-ch2.html>

Some basic information about climate in the Great Lakes region.

<http://www.ucsusa.org/greatlakes/pdf/temperature.pdf>

More detailed look at the impact of climate change on the Great Lakes region.

<http://www.great-lakes.net/envt/refs/weather.html>

A site that provides weather information for local areas.

Transportation

<http://www.vtppi.org/tca/tca0514.pdf>

Chapter 14 of the Victoria Transport Policy Institute’s *Transportation Costs and Benefits Analysis* guide focuses on “Land Use Impacts.” It provides a comprehensive and detailed account that may be helpful background information for the teacher wanting to have a more detailed understanding of the connections between urban sprawl and transportation modes. In particular, the “Environmental Degradation” section (pages 5 - 8) in this chapter bears very directly on the culminating task outlined above.

<http://www.niwa.cri.nz/ncces/co2calc/>

This New Zealand Residential CO₂ Calculator site allows students to calculate the amount of CO₂ produced by cars using gas or diesel, when distance (in km) is used.

<http://www.ene.gov.on.ca/cons/371706.htm>

Ontario’s Drive Clean Program site.

<http://www.eia.doe.gov/oiaf/1605/gg96rpt/chap2.html>

This site shows that CO₂ emissions from transportation produces about one-third of USA carbon emissions.

Other Sites

<http://www.ekes.org/climate/individaction.html>

Individuals taking action to help the environment.

http://climatechange.sea.ca/climate_change.html

An overview of climate change – brief history, the debate, the greenhouse effect, the causes/sources, implications of temperature rise and the Kyoto protocol.

Appendix 1.1 *Checklist of Preparation - A Case Study of the Environmental Impacts of Transportation Choices*

As you work through the course of study, remember to use the checklist periodically to track the key ideas and skills you are acquiring as you prepare for the final assignment.

Checklist of Preparation

I can

- identify biotic and abiotic factors in an ecosystem
- research information about an ecosystem
- find and interpret data about ecosystems
- ask questions about the impact of chemical processes on the environment
- identify chemical products of vehicle exhaust
- compare the exhaust production of different fuels
(gas, diesel, electric, hydrogen)
- describe the flow of water (run-off, precipitation) for a specific area
- describe extreme weather events for a specific area
- find and analyse different transportation routes
- assess the environmental impact of different methods of transportation

Appendix 1.2 *Summary of the Kyoto Protocol*

Countries around the world have recognized that climate change affects us all. The volume of greenhouse gases produced by human activity, added to the gases occurring naturally in the atmosphere, has led to extreme weather events, temperature changes and the melting of the Arctic icecaps.

In December 1997, Canada and more than 160 other countries met in Kyoto, Japan, and agreed to targets to reduce greenhouse gas emissions. The agreement that set out those targets, and the options available to countries to achieve them, is known as the Kyoto Protocol. Canada's target is to reduce its greenhouse gas (GHG) emissions to 6 percent below 1990 levels by the period between 2008 and 2012. The goal of Kyoto is to reduce the total emissions of industrialized countries to 5.2% below 1990 levels.

The Government of Canada and the provincial/territorial and municipal governments are working together to achieve reductions in greenhouse gases. Investment in new technologies will help business to operate in a more efficient way and Canadians will benefit by having a cleaner environment. The Kyoto Protocol allows the presence of carbon sinks to count toward a country's commitment to reduce greenhouse gases. A "sink" is any process that removes greenhouse gases from the atmosphere. For example, forests form a carbon "sink" through the process of photosynthesis – trees and other plants take

up carbon dioxide (CO₂) and break it down. The oxygen (O₂) is released and the carbon (C) becomes part of the tree.

The Kyoto Protocol allows countries to buy carbon credits from other countries. This means that countries that reduce their greenhouse gas emissions by more than is required under Kyoto can sell their unused carbon credits to countries that find it difficult or expensive to reduce emissions¹. This is called emissions-reduction trading. In other words, countries that have "overperformed" (met and exceeded their target for reduction) may sell their "unused right to pollute" to countries that have failed to meet their emissions reduction target. Canada believes that a solution that uses the market has a part to play in achieving an overall reduction of greenhouse gases globally.

It is important that countries that have signed the Kyoto Protocol comply with the rules. To that end, Canada is working to build an effective way to measure whether everyone is doing their part. This is a way of checking that countries obey the rules agreed upon, giving them strong incentives to take their commitments seriously.

*Based in part on information found
at www.climatechange.gc.ca.*

*For a glossary of terms, please see the
Resources section at the end of this document.*

¹ While it may appear strange that one country can buy the right to pollute from another country, remember that the total emissions of participating countries selling and buying carbon "credits" are to reach the agreed upon targets between 2008 and 2012. Some believe that countries being able to pay others in order to keep polluting is wrong; others say that it is a way of encouraging those who can to make greater reductions while penalizing those who don't.

Appendix 1.3 *Student Task and Expectations: A Case Study of the Environmental Impact of Transportation Choices*

Purpose: Assess the environmental impacts of different transportation choices and propose a transportation strategy to remove Toronto's garbage.

Background: Solid waste (garbage) is often stored in landfill sites or incinerated. With the closure of the local landfill, Toronto's garbage is transported by truck to Michigan. Trucks transport solid waste from Toronto to Michigan, driving along Highway 401, traveling through areas with sensitive ecosystems or different land uses. People living near these areas are concerned about how this transportation choice affects them.

Scenario: Various people (farmer, transport company employee, reporter, municipal councilor, environmental activist) in the Toronto area have been asked to create a proposal that will reduce the environmental impacts of transporting waste.

Assignment: Complete an Environmental Impact Form. Then, students will choose (or be assigned) one of the following roles: farmer, transport company employee, reporter, municipal councilor, environmental activist. Using this assumed perspective, propose a strategy to reduce the environmental impacts of transporting waste. Create a flyer to act as a cover page that could be sent to members of city council, lobbying for a strategy that will:

- ▶ support your position;
- ▶ describe the effects on a specific ecosystem;
- ▶ describe the effects on the global climate and
- ▶ support the goal of the Kyoto Protocol to reduce greenhouse gas emissions.

Expectations: Use this list of expectations, along with Appendix 1.1 *Checklist of Preparation* to help you complete your assignment.

- ▶ examine how abiotic factors affect the survival and geographical location of biotic communities [e.g., fresh water, soil composition, temperature]
- ▶ assess the impact of technological change and natural change on an ecosystem
- ▶ identify and evaluate Canadian initiatives in protecting Canada's ecosystems [e.g., Kyoto, National Parks]
- ▶ describe and explain qualitatively how factors such as energy, concentration, and surface area can affect rates of chemical reactions [and affect an ecosystem]
- ▶ name and write the formulae of common ionic and molecular compounds, using a periodic table and an IUPAC table of ions [for compounds now found in the ecosystem]
- ▶ represent simple chemical reactions using molecular models, word equations, and balanced chemical equations [to show how new compounds are formed]
- ▶ explain how environmental challenges can be addressed through an understanding of chemical substances [e.g., can adding new substances moderate the impact of pollutants?]
- ▶ describe and explain heat transfer within the water cycle and how the hydrosphere and atmosphere act as heat sinks [how do changes in local heat production affect local weather through the water cycle]

- ▶ describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents
- ▶ investigate factors which affect the development, severity, and movement of global and local weather systems [What are the incidents of severe weather? Are global systems causing changes?]
- ▶ analyse everyday phenomena and technologies in terms of the motions involved [e.g., consider alternate transport systems]
- ▶ identify and evaluate Canadian initiatives in protecting Canada's ecosystems [such as the Kyoto Protocol]
- ▶ analyse how technology is used for tracking the motion of objects and outline the kinds of scientific knowledge gained through the use of such technologies
- ▶ select and integrate information from various sources, including electronic and print resources, community resources, and personally collected data, to answer the questions chosen
- ▶ analyse data and information and evaluate evidence and sources of information, identifying flaws such as errors and bias

Appendix 1.4 *Environmental Impact Form (1)*

PROBLEM: What activity do you think changes the environment?	
Ecosystem (Which ecosystem[s] is [are] affected by this activity?)	
What factors are changed by this human activity?	
Abiotic Factors	Biotic Factors
Human Activity {describe}	

Appendix 1.4 *Environmental Impact Form (2)*

Factors from this activity that affect the environment	
Relevant Chemical Reactions	Heat Generation
Movement or Transportation Issues	

Appendix 1.4 *Environmental Impact Form (3)*

Impact of Change on Ecosystem
Weather Systems Affected
Risk Related to this Activity
Attach relevant data or documents to this report

Appendix 1.5 *Evaluation Rubric for Environmental Impact Form*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts	Concepts are simple, with gaps	Concepts are mostly simple and complete	Ideas are developed with some depth	Concepts are complete and developed with insight
K/U Facts and terms used accurately and connect to concepts presented	Facts and terms are presented with limited accuracy and loosely connect to the concepts presented	Facts and terms used accurately and appropriately for the concepts presented	Facts and terms are used accurately and they connect and support concepts presented	Facts and terms effectively support the ideas presented so that the concepts are understood more easily
I Analysis and interpretation of data	Limited analysis and interpretation of data	Moderate analysis and interpretation of data	Considerable analysis and interpretation of data	Thorough analysis and interpretation of data
C Accurate use of scientific terminology, symbols, conventions and SI units	Limited accuracy of scientific terminology, symbols, conventions and SI units	Moderate accuracy of scientific terminology, symbols, conventions, and SI units	Considerable accuracy of scientific terminology, symbols, conventions, and SI units	A high degree of accuracy of scientific terminology, symbols, conventions, and SI units
C Use of information technology for scientific purposes	Researches appropriately, using the given resources	Researches appropriately using the given resources and useful additional sites	Researches appropriately using the given resources and additional sites that are effective	Researches appropriately using given sites and a variety of additional sites that are highly effective
MC Assessment of impacts of science and technology on the environment	Identifies how an ecosystem is at risk as a result of a specific activity	Explains how an ecosystem at risk is affected as a result of a specific activity	Explains how an ecosystem can be affected by particular aspects of the specific activity	Explains the impact of different elements of the specific activity on particular aspects of an ecosystem

Appendix 1.6 *Evaluation Rubric for Flyer*

Description	Level 1	Level 2	Level 3	Level 4
K/U Understanding of concepts presented	Concepts presented are simple, with gaps	Concepts are mostly simple and complete	Concepts are developed with some depth	Concepts are complete and developed with insight
K/U Understanding of relationships between concepts	Concepts presented are simple, with gaps	Concepts presented show simple connections	Concepts have clear connections presented	Concept connections support and develop concepts thoroughly
C Communication of information and ideas	Information and ideas are vague and presented with doubt	Information and ideas are complicated or difficult to understand	Information and ideas are presented clearly and understandably	Information and ideas are presented simply, clearly and are easy to understand
C Communicates with a purpose for the given audience	Audience and purpose inconsistent	Audience and purpose consistent	Clear and consistent sense of audience and purpose	Strong, clear sense of audience and purpose
C Use of flyer form	Text and graphics show limited command of the flyer form	Text and graphics show moderate command of the flyer form	Text and graphics show considerable command of the flyer form	Text and graphics show extensive command of the flyer form
MC Proposing courses of practical action in response to problems identified	Extends analyses of problems into courses of practical action with limited effectiveness	Extends analyses of problems into courses of practical action with moderate effectiveness	Extends analyses of problems into courses of practical action with considerable effectiveness	Extends analyses of problems into courses of practical action with a high degree of effectiveness