

***Unit G: Investigative Project***

***Half Course V***

## ***HALF COURSE V***

### **Unit G: Investigative Project**

**Hours: 5**

#### **General Learning Outcome:**

**Complete an investigative project related to consumer mathematics skills, strategies, and activities.**

*The intent of this unit is to have students complete an investigative project. The project is to be based on an open-ended question. The question is not meant to have one correct answer/conclusion or one approach to its solution. It is intended that students set up situations, gather data, and draw reasoned conclusions based on both their data and related circumstances in the real world. The entire project is to be presented as a written report.*

#### **Specific Learning Outcomes**

- G-1 Conduct an investigation requiring the use of data and mathematical problem solving and decision making.
- G-2 Develop a structured report of an investigative study related to consumer mathematics.

# ***INVESTIGATIVE PROJECT***

## **Instructional Materials**

- *Essentials of Mathematics 12*

PRESCRIBED LEARNING  
OUTCOMES

SUGGESTIONS FOR INSTRUCTION

**General Outcome**

Complete an investigative project related to consumer mathematics skills, strategies, and activities.

**Specific Outcome(s)**

G-1 conduct an investigation requiring the use of data and mathematical problem solving and decision making

G-2 develop a structured report of an investigative study related to consumer mathematics

A primary goal of Consumer Mathematics centres on decision making. Students in *Senior 4 Consumer Mathematics* are expected to make and to justify decisions throughout the course. In this unit, students are required to make a reasoned decision and to justify that decision using data gathered locally, nationally, and/or internationally.

The assigned project is to provide students with an opportunity to collect and analyze data. Frequently, analysis of data requires a situation within which to frame conclusions. The project is not meant to have one correct answer/conclusion or one approach to its solution. It is intended that students set up situations, collect data, and draw reasoned conclusions based on their data and related circumstances in the real world.

A format for the investigative project is critical. Teachers could encourage students to use a familiar inquiry format from English language arts or science. Regardless of the style or format used, students are expected to provide

- an **introduction** that presents the problem, pertinent definitions, and any special circumstances that will have an impact on the decision(s) reached
- a **body** of the project that presents the data gathered and the arguments used to support all claims
- a **conclusion** that follows logically from the data
- a **bibliography** that identifies all sources (the bibliography should follow an acceptable style)

✓ Communications	Patterns
✓ Connections	Problem Solving
Number Sense	✓ Reasoning
✓ Organization and Structure	Technology
	Visualization

— *continued*

**SUGGESTIONS FOR ASSESSMENT**

In summative assessment, students of *Senior 4 Consumer Mathematics* should be asked to demonstrate a number of learning outcomes through complex tasks. The Investigative Project is one such task. An assessment rubric is one tool that can assist both teachers and students to clarify expectations. Rubrics are useful if they are appropriate to the assigned task and if they provide an accurate description of student learning. Rubrics are time-consuming to develop but both teachers and students find that the process of collaborating in developing an assessment rubric is a useful learning experience.

Investigative Projects used during the field validation of *Senior 4 Consumer Mathematics* (1998-2000) were marked using the following rubric.

<p><b>Level 1 Little Understanding Demonstrated</b></p> <ul style="list-style-type: none"> <li>— little knowledge demonstrated</li> <li>— nearly all statements incomplete or unfounded</li> <li>— statements barely understandable</li> </ul>	
<p><b>Level 2 Partial Understanding Demonstrated</b></p> <ul style="list-style-type: none"> <li>— showed partial but limited knowledge</li> <li>— statements lacked substantive explanation or thought</li> <li>— some incomplete or misdirected statements</li> </ul>	
<p><b>Level 3 Substantial Understanding Demonstrated</b></p> <ul style="list-style-type: none"> <li>— showed essential knowledge in response</li> <li>— most responses complete</li> <li>— some justifications showed incomplete thought</li> </ul>	
<p><b>Level 4 Comprehensive Understanding Demonstrated</b></p> <ul style="list-style-type: none"> <li>— showed a comprehensive knowledge</li> <li>— thoughtful responses</li> <li>— comprehensive arguments with good justification</li> </ul>	

**SUGGESTED LEARNING RESOURCES**

**Print**

Baron, C., et al. *Essentials of Mathematics 12*. Victoria, BC: British Columbia Ministry of Education, 2003. [ISBN 0-7726-4997-9]

Ainsworth, Larry, and Jan Christinson. *Student Generated Rubrics: An Assessment Model to Help All Students Succeed*. Palo Alto, CA: Dale Seymour Publications, 1998.

Schoenfeld, Alan, et al. *Balanced Assessment for the Mathematics Curriculum: High School Assessment*. Dale Seymour Publications, 2000.

Refer to *Senior 4 English Language Arts: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 2000, General Learning Outcome 3 (Inquiry), for steps in the inquiry process. In particular, refer to pages 222 and 265.

**PRESCRIBED LEARNING  
OUTCOMES**

G-1 conduct an investigation requiring the use of data and mathematical problem solving and decision making  
– *continued*

G-2 develop a structured report of an investigative study related to consumer mathematics  
– *continued*

**SUGGESTIONS FOR INSTRUCTION**

Teacher feedback from *Senior 4 Consumer Mathematics* field validation indicated that students had difficulty starting their projects. Teachers could, therefore, brainstorm with students to start the projects. Students should be encouraged to identify possible scenarios, situations, or circumstances to investigate. After the initial brainstorming session, students should work on their own or in small groups to complete their projects.

The following are suggestions that pilot teachers found useful.

- Model, through class discussion and activities, what is expected in the Investigative Project. Use an example, which would be of interest to students, such as “What is the best vehicle?”
- Encourage students to define key words or terms used in the question or project.
- Have students identify possible scenarios or situations for their investigative project.
- Identify a deadline for completion of the Investigative Project. Keep in mind that students have a second major project (Career/Life Project) to be completed in Half Course VI, and students will need some time at the end of the course to complete their portfolios.

Possible topics for an investigative project include:

- What is the best non-alcoholic beverage?
- Which non-motorized vehicle is best?
- What is the best company for long distance telephone rates in Manitoba?
- What is the best cereal grain to grow in Manitoba?
- What is the best television series?
- Who is the best comedian?
- What is the best method for receiving television programming? (Students could compare using an antennae, cable, or satellite dish.)
- What is the best diet?
- What is the best sandwich?
- What is the best brand of denim jeans?

✓ <b>Communications</b>	Patterns
✓ <b>Connections</b>	Problem Solving
Number Sense	✓ <b>Reasoning</b>
✓ <b>Organization and Structure</b>	Technology
	Visualization

— *continued*

**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**

Scoring of the projects during the field validation was based on the following:

- Introduction
  - Definition of “best.”
  - Indication of the situation or criteria to be considered in the project. More than one situation must be considered.
  - Indication of what the student is trying to establish.
- Data Presentation
  - Data must be relevant to what the student is trying to establish.
  - All data must clearly identify what the data represent.
  - The source of all data must be identified. A bibliography should be included at the end of the project.
- Data Analysis
  - Identify significant information/trends in the data. Such information must support what the student is trying to establish in the project.
  - Valid conclusions based on the data are stated.
- Overall Presentation and Organization
  - The elements of a good essay (introduction, body, conclusion, and bibliography) are easily identifiable.
  - The project report is free of grammatical and spelling errors.
  - The project report is neat and easy to read.

Scoring:				
	1 Introduction	2 Data Presentation	3 Data Analysis	4 Presentation and Organization
Low	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
↓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
↓	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
High	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**PRESCRIBED LEARNING  
OUTCOMES**

**SUGGESTIONS FOR INSTRUCTION**

G-1 conduct an investigation requiring the use of data and mathematical problem solving and decision making  
– *continued*

G-2 develop a structured report of an investigative study related to consumer mathematics  
– *continued*

In each case, students would need to define “best.” The definition could be in terms of sales, number of users, preference, cost, reliability, etc. Data could be obtained from student-conducted surveys and interviews, school and/or public libraries, newspapers and other print sources, the Internet, etc. Students need to understand that their project would be enhanced through using multiple definitions of “best” and by using several data sources. Also, students must be told that surveying 20 of their friends, for example, is not considered sufficient data.

✓ <b>Communications</b>	Patterns
✓ <b>Connections</b>	Problem Solving
Number Sense	✓ <b>Reasoning</b>
✓ <b>Organization and Structure</b>	Technology
	Visualization

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING  
RESOURCES

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# Appendix

## Quantitative Research

Students undertaking the Investigative Project in Half Course V may include a survey as one of their approaches to gathering data. This appendix, Quantitative Research, provides information that will help students in preparing the survey.

### Using Surveys Responsibly

It is essential that students apply critical thinking to their primary research. Limit the number of surveys conducted within the class or school, and ensure that students follow basic principles of primary research in order to collect valid data.

Class discussion or a teacher conference may be appropriate for students who have just been introduced to the principles of valid surveying.

Before any questionnaire is administered, ensure that it is piloted and that it is sound with respect to the following:

- *Purpose:* Surveys may have a practical or theoretical purpose:
  - *practical purpose* (e.g., How many hours would students be willing to volunteer to work in a student radio station?)
  - *theoretical purpose* (e.g., Is there a correlation between students' achievement in school and the amount of time they spend reading outside of school?)

Ask students to identify their purpose. Discuss with them whether this purpose can be met best through primary research, and whether the questions they propose for their questionnaire are consistent with their purpose.

- *Appropriateness:* Do not permit questionnaires that ask for private information. Questionnaires that explore sensitive areas pose problems of confidentiality within a school setting and may not yield valid results because of respondents' concern with protecting their privacy.
- *Practicality:* Interpreting complex survey data requires expertise that is beyond the expectations of *Senior 4 Consumer Mathematics*. Encourage students to keep surveys simple and ensure that their plans for gathering, analyzing, and sharing information are realistic.
- *Clarity:* Be sure that questions are unambiguous and that students have defined their terms (e.g., If students want to discover whether a correlation exists between self-esteem and participation in team sports, they must first consider how they can define self-esteem and whether they have the means to gauge it).

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**Quantitative Research:** Adapted from *Senior 4 English Language Arts: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 2000. Appendices 36 to 40.

- **Reliability:** Discuss with students the various factors that affect the reliability of their research data. Some of these factors are:
  - *sampling methods* (e.g., If the survey is optional, what impact will self-selection have?)
  - *survey methods* (e.g., Would the results be different if the survey was anonymous?)
  - *accuracy of response* (e.g., How accurate is the respondents' recall of factual information likely to be? What factors may affect their perceptions?)
  - *validity of generalizations* (e.g., Does surveying people at a specific time provide information that can be generalized to other situations?)

### Choosing a Survey Method

Suggest that students construct their questionnaires for easy analysis, keeping in mind the type of information they are seeking (e.g., comparing groups, looking for cause-and-effect or correlation, looking for change over time). Students may wish to experiment with various ways of eliciting the same information through piloting two different survey forms.

Survey responses can be categorized as closed or open. Types of surveys and the purpose and advantages of each are summarized in the following chart:

**Comparing Types of Surveys**

Closed Responses	Purpose and Advantages
<ul style="list-style-type: none"> <li>• <i>fixed-response questions:</i> multiple choice, agree-disagree, checklists</li> <li>• <i>rating scales:</i> numerical scales, ranking of items in order of preference, category scales (e.g., frequently, sometimes, never)</li> </ul>	<ul style="list-style-type: none"> <li>• Responses are easier to tally, categorize, and analyze</li> <li>• Response options remind respondents of items they may forget otherwise</li> </ul>
Open Responses	Purpose and Advantages
<ul style="list-style-type: none"> <li>• <i>open-ended questions:</i> (e.g., Why did you enroll in this workshop?)</li> <li>• <i>phenomenological research:</i> extended interviews in which the interviewer invites subjects to expand on the topic through prompts such as "Tell me more."</li> </ul>	<ul style="list-style-type: none"> <li>• Allow for responses the questioner may not have anticipated in fixed-response questions.</li> <li>• Allow respondents to provide more complex information.</li> </ul>

## Choosing a Valid Research Sample

In general, valid surveys collect a small amount of data from a large sample, or a large amount of data from a small sample. Students need to consider the following:

- *Target group:* On the basis of the information they are collecting, students decide on a target group or population based on age, sex, income, occupation, location, affiliation, or other criteria.
- *Sample:* Students determine the number of respondents they need to provide a valid sample of the responses of this target group. Although professional researchers use more sophisticated means to determine a sample, 10 percent of a target population is generally considered an adequate sample (Alreck and Settle, 1985, 88, 89).
- *Random selection:* Students develop a system to ensure that the people in their sample are randomly selected. Simply distributing a questionnaire in the school lunchroom at noon hour does not ensure random selection, because it may eliminate certain groups in the school population. Students may want to try
  - *simple random sampling* (e.g., selecting every fifth name on a list)
  - *stratified random sampling:* taking a specified number of respondents from subgroups in a population (e.g., males and females). This type of sampling allows students to compare the responses of various groups.
  - *accidental sampling* (e.g., surveying the first 20 people to exit a building). This is a convenient method, but the sample may be biased by various factors.

## Wording and Ordering Survey Questions

Ask students to develop a list of tips for wording and ordering the questions on questionnaires, based on samples of professional surveys. Their tips may include the following:

### Tips for Wording and Ordering Survey Questions

1. State the purpose of the survey.
2. Ask demographic questions if you wish to look for correspondences between groups.
3. Use simple and precise language and keep the questionnaire short.
4. Be sure that all questions are relevant to your purpose.
5. Avoid response categories that overlap.
6. Be sure that all categories are exhaustive, or leave space for "other."
7. Avoid loaded questions and built-in assumptions (e.g., Are you in favour of increasing the driving age to 18 to reduce traffic fatalities among teenagers?)
8. Be consistent in formatting questions.
9. Sequence questions logically, beginning with general questions and moving to specific questions.
10. Be sure that the questionnaire is neat, attractive, and free of errors.

## Piloting a Survey

Ask students to pilot all surveys with a small number of respondents from the target population, and to assess their pilot surveys by responding to questions such as the following:

- Did respondents misinterpret certain questions? How can you tell? How can these questions be reworded to make them clear?
- What, if any, comments did respondents write in margins?
- Were there questions to which almost everyone responded with the same answer? Do you need to ask these questions?
- Were there questions that a high percentage of respondents did not answer? Can you determine why?
- If you used closed questions, did a high number of respondents choose "other"?
- If you used open-ended questions, did responses fall into clear categories? Was your "miscellaneous" category too large?
- Did this survey form elicit the sort of information you hoped to gather?

## Collecting and Analyzing Results

Students collect and analyze their results using a two-step process:

1. Sort responses to each question into categories and tally the number of responses in each category.
2. Measure the relationship between categories. This may mean producing averages, comparing groups, and looking for correlation or cause and effect.

## Reporting Results

Responses to closed questions are often reported numerically through charts and graphs. Responses to open-ended questions, especially phenomenological research, are usually reported in written text that observes similarities and differences among respondents, and reflects on reasons for these similarities and differences.

Students using visuals must select the kind of visuals that best represent their data. Ask students to bring to class samples of line graphs, pie graphs, bar graphs, and stacked bar graphs from textbooks, brochures, newspapers, and magazines. Ask them to determine the type of visual that represents various kinds of data:

- how things change over time (line graph)
- how parts compare; proportions of a whole (pie chart)
- how things compare at one point in time (bar graph)
- how things compare, as well as how the parts of each thing compare (stacked bar graph)

Suggest that students experiment with representing their information in different kinds of visuals.

## Reflecting on Results

Reflection and assessment are essential in any form of primary research. After a survey is completed, provide questions to support students in various aspects of self-assessment.

Students need to reflect on the following:

- *Choice of research method:* Did a survey or questionnaire lead me to the sort of information I was seeking?
- *Survey processes:* Did I select the most appropriate survey method, the right target group and sample, and the most pertinent questions? How could I have improved my survey processes?
- *Data:* Are the data I collected complete and accurate?
- *Learning:* What knowledge did I gain and what are the implications of this knowledge?

### Teacher Resources

Alreck, Pamela L., and Robert Settle. *The Survey Research Handbook: Guidelines and Strategies for Conducting a Survey*. Toronto, ON: CANAV Books, 1985.

Chiseri-Strater, Elizabeth, and Bonnie Stone Sustein. *Field Working: Reading and Writing Research*. Upper Saddle River, NJ: Prentice Hall, 1997.

Fink, Arlene, and Jacqueline B. Kosecoff. *How to Conduct Surveys: A Step-by-Step Guide*. Thousand Oaks, CA: Sage, 1985.

Jeroski, Sharon, Lynn Booth, and Maureen Dockendorf. *Field-Based Research: A Working Guide*. Victoria, BC: British Columbia Ministry of Education, 1993.