

Course
MTH-3052-2
Data Collection

Mathematics



INTRODUCTION

The goal of the *Data Collection* course is to enable adult learners to deal with situations that involve collecting or processing data pertaining to a one-variable distribution.

In this course, adult learners draw conclusions or make informed decisions based on the results of a statistical report. The data collected, whether discrete or continuous, are represented using various tools (tables, graphs, measures) that make it possible to synthesize information about a given population. The situational problems presented involve the use of statistical reasoning to produce, compare or critically examine different studies. They therefore provide an opportunity for adult learners to analyze data and justify their conclusions using tools such as statistical measures and graphs. Adult learners also interpret different statistical measures and information contained in drawings and geometric constructions. To process data resulting from random experiments, they represent, interpret and compare probability data by enumerating possibilities and calculating probabilities (discrete and continuous random variables). In some situational problems, adult learners organize data from a sample, whether or not they have collected the data themselves, in order to describe a population and draw conclusions. They also analyze distributions using the appropriate statistical measures or critically examine an existing study. In others, they compare measures to qualify and quantify probabilities and, depending on the case, use experimental or theoretical probabilities to predict and validate results.

By the end of this course, adult learners will be able to use data collection as a tool and compare the results of a statistical experiment using different instruments to validate their observations of a problem that they themselves have identified. They will present the results of their analysis in accordance with the rules and conventions of mathematics. They will use problem-solving strategies to determine the most appropriate solution. In addition, they will use mathematical reasoning to interpret probability data resulting from a random experiment and make decisions.

SUBJECT-SPECIFIC COMPETENCIES

In order to solve the situational problems in this course, adult learners will use the following three subject-specific competencies:

- *Uses strategies to solve situational problems*
- *Uses mathematical reasoning*
- *Communicates by using mathematical language*

The use of effective strategies involves employing rigorous mathematical reasoning and communicating clearly by observing the codes and conventions of mathematical language. Adult learners solve situational problems by using all three subject-specific competencies and other resources.

The following section explains how to use the three subject-specific competencies to solve a situational problem.

PROCESS AND STRATEGIES

To solve a situational problem, adult learners need effective strategies that they can adapt to the situations at hand.

Adult learners solve situational problems using a four-phase process:

- **representation**
- **planning**
- **activation**
- **reflection**

The following table gives an overview of the phases in the problem-solving process, as well as a few examples of strategies adult learners can use in dealing with various situations. These phases are not necessarily carried out in the order indicated above. Adult learners may have to go back and forth among the four phases in order to solve a situational problem.

PROCESS AND STRATEGIES	
REPRESENTATION	
<ul style="list-style-type: none"> - Adult learners examine the situational problem to identify the context, the problem and the task to be performed, and suitably master the elements of mathematical language. - In attempting to understand the context and the problem, they use deductive reasoning. 	
Examples of strategies	<ul style="list-style-type: none"> • Identifying relevant information given verbally, graphically, in a table of values or in a diagram • Describing the situation in their own words and comparing their understanding of the problem with that of their classmates and teacher • Organizing data from a sample in order to describe a population and make it easier to process the information • Proceeding by analogy with games of chance (e.g. working with dice, cards or other objects to determine the constraints in a random experiment)
PLANNING	
<ul style="list-style-type: none"> - Adult learners look for ways of approaching the problem and choose those that seem the most efficient. - In planning the solution, they use different types of reasoning to work out the steps involved. They can refer to similar situations they have solved in the past. - They develop a plan, taking into account the elements of mathematical language (symbols, terms and notation used, and the different registers of representation). 	
Examples of strategies	<ul style="list-style-type: none"> • Comparing the situation with other situations they have already studied in order to identify any similarities • Dividing the situational problem into subproblems • Determining the main steps in a plan aimed at developing an intuitive correlation model • Developing an appropriate counting method when studying the concept of fair game
ACTIVATION	
<ul style="list-style-type: none"> - In developing their reasoning, adult learners propose probable or plausible ideas, anticipate the implications of these ideas and use examples to find invariants. - They make rigorous use of mathematical language and, to avoid confusion, they use the symbols terms and notation in accordance with their meaning. 	
Examples of strategies	<ul style="list-style-type: none"> • Referring to previously studied situational problems • Using a table to connect the elements associated with the correlation: ordering the statistical data, finding the mode, the median or the weighted mean • Drawing the line of best fit through a scatter plot
REFLECTION	
<ul style="list-style-type: none"> - Adult learners use a reflective approach throughout the situation and always review the phases in the problem-solving process and the choices made, with a view to validating the solution. This reflection helps them hone their ability to use exact mathematical language. 	
Examples of strategies	<ul style="list-style-type: none"> • Comparing their results with the expected results and those of others • Checking their solution by, for example, comparing different measures of central tendency, or validating quartile measures using the corresponding graph • Identifying the strategies used to deal with the situation • Using a set of metacognitive questions such as <i>Why did I proceed in this way? Is there a better way of doing this?</i> • Using a spreadsheet program to validate their work

CROSS-CURRICULAR COMPETENCIES

Cross-curricular competencies are not developed in a vacuum; they are rooted in situational problems. To varying degrees, the cross-curricular competencies contribute to the development of the subject-specific competencies, and vice versa.

Several cross-curricular competencies can be useful in dealing with the family of learning situations *Processing data*. Two of these are considered particularly relevant to this course: *Exercises critical judgment* and *Communicates appropriately*.

Intellectual Competency

As the saying goes, there are lies, white lies and statistics. In collecting data, adult learners use the competency *Exercises critical judgment* before forming an opinion and drawing conclusions about their study. They are able to assess the extent to which reason and emotion influence their actions and to base their thinking on a logical and ethical foundation. This competency enables them to form, express and qualify their opinion by objectively and rigorously examining the facts, and by choosing an appropriate graph and scale to present the results as objectively as possible.

Communication-Related Competency

The competency *Communicates appropriately* is often used in presenting the results of a study. Graphs, histograms and distributions are generally used to convey information in an organized manner in order to convince or inform others. The situational problems in this course could foster the development of this competency by giving adult learners the tools to organize their thinking and share their opinions about current events, which enables them to use an appropriate mode of communication.

SUBJECT-SPECIFIC CONTENT

In this course, adult learners use and build on their previously acquired knowledge of statistics. In order to deal effectively with situational problems, they will add to what they have learned by mastering the mathematical knowledge specific to this course.

Prescribed Knowledge

In order to deal effectively with the learning situations in this course, adult learners develop the following three integrative processes:

- **collecting data**
- **comparing collections of data**
- **interpreting data resulting from an experiment**

These processes, which are applied in the learning situations in this course, foster the integration of mathematical knowledge and the subject-specific competencies. The learning situations must involve at least one of these integrative processes. However, there must be a sufficient variety of learning situations to cover all three processes. The learning situations may be purely mathematical or based on everyday events.

Mathematical Knowledge	Restrictions and Clarifications
One-variable statistical distributions	
<ul style="list-style-type: none"> • Organizing and interpreting statistical data 	The sampling methods studied in this course are: <ul style="list-style-type: none"> • stratified • cluster
<ul style="list-style-type: none"> • Constructing and interpreting distributions 	In this course, data is interpreted and tables are constructed using: <ul style="list-style-type: none"> • tables of condensed data • tables with data grouped into classes
<ul style="list-style-type: none"> • Representing and interpreting graphs 	The graphs studied in this course are: <ul style="list-style-type: none"> • the histogram • the box-and-whisker plot
<ul style="list-style-type: none"> • Calculating measures of central tendency and dispersion 	The measures of central tendency studied in this course are: <ul style="list-style-type: none"> • the mode • the median • the weighted mean <p>The only measure of dispersion studied in this course is the range of each part of a box-and-whisker plot (including the interquartile range).</p>

Mathematical Knowledge	Restrictions and Clarifications
Probability	
<ul style="list-style-type: none"> Enumerating possibilities and calculating probabilities 	<p>Two types of random variables are studied in this course:</p> <ul style="list-style-type: none"> discrete continuous <p>The enumeration of possibilities and the calculation of probabilities is carried out in various situations, including those that deal with measurement (including geometric probabilities)</p> <p>Since reasoning is used to perform calculations (arrangement, permutation and combination), it is not necessary to use counting formulas.</p>
<ul style="list-style-type: none"> Representing events 	<p>Events are represented by means of:</p> <ul style="list-style-type: none"> tables tree diagrams graphs geometric figures

Cultural References

The forecasting aspect of statistics dates back to the 18th century, with the advent of the first mortality tables. The ability to determine life expectancy led to the creation of the first life insurance companies. Since then, statistical data processing has spread to other fields. For example, some specialists can determine the risk of having your car stolen if you live in a certain area. Moreover, insurance companies establish their rates on the basis of this type of statistical data. This knowledge could help adult learners make more informed choices.

The world of sports is replete with statistics, and adult learners could draw on such material. If they are so inclined, they could track performances in a particular sport since the creation of the modern Olympic Games, and predict trends or possible limitations regarding human capabilities, for instance in swimming or running. They could also track the development of techniques and materials used to shave off the clock the precious thousandths of a second that go into making a world champion. Adult learners who are interested in hockey could make graphs or tables of statistics in order to make predictions.

FAMILY OF LEARNING SITUATIONS

The situations in the family *Processing data* involve problems that can be solved in part by collecting or processing data. The *Data Collection* course provides adult learners with an opportunity to learn how to collect and compare data.

In the situational problems in this course, adult learners organize data from a sample in order to describe a population and draw conclusions, interpret data resulting from a statistical study or a random experiment, or take a position on the basis of statistical or probability data.

BROAD AREAS OF LEARNING

The broad areas of learning deal with major contemporary issues. Ideally, the situations to be studied should be selected in keeping with the educational aims of the broad areas of learning, which provide the situational problems with contexts that make the learning process meaningful. Three broad areas of learning are considered particularly relevant to this course: Media Literacy, Citizenship and Community Life, and Environmental Awareness and Consumer Rights and Responsibilities.

Media Literacy and Citizenship and Community Life

In fulfilling their duties as citizens, especially during an election campaign, adult learners are exposed to numerous polls and statistical studies. This course provides them with the tools to better understand, interpret and compare these data. A deeper understanding of data-collection methods, in particular sampling methods, fosters the development of a critical attitude toward statistics presented in the media and toward the media per se, which reflects the educational aim of the broad area of learning Media Literacy. In this way, adult learners can participate in a more informed way in the democratic life of their society, thus achieving the educational aim of the broad area of learning Citizenship and Community Life.

Environmental Awareness and Consumer Rights and Responsibilities

Different situations that involve analyzing statistical studies may prove useful in helping adult learners take a critical look at consumer behaviour in a society. Among other things, this might mean examining the origin of various consumer products; the impact of globalization on cultures, ways of life and the distribution of wealth; the working conditions of those who produce goods or provide services and the fair distribution of resources. Developing an awareness of the social, economic and ethical aspects of consumption is consistent with the educational aim of this broad area of learning.

EXAMPLE OF A LEARNING SITUATION

All learning situations and situational problems, regardless of the broad area of learning to which they are related, require the active participation of the adult learner. They provide an opportunity to develop the targeted subject-specific and cross-curricular competencies, to acquire mathematical concepts and to mobilize a variety of useful resources.

The table below presents the elements needed to develop a learning situation or situational problem. It specifies these elements for the situational problem described on the following page.

ELEMENTS NEEDED TO DEVELOP A LEARNING SITUATION OR A SITUATIONAL PROBLEM	
Targeted broad area of learning	<ul style="list-style-type: none"> • Media Literacy • Citizenship and Community Life
Prescribed subject-specific competencies	<ul style="list-style-type: none"> • Uses strategies to solve situational problems • Uses mathematical reasoning • Communicates by using mathematical language
Prescribed family of learning situations	<ul style="list-style-type: none"> • Processing data
Targeted cross-curricular competencies	<ul style="list-style-type: none"> • Exercises critical judgment • Communicates appropriately
Prescribed essential knowledge	<ul style="list-style-type: none"> • See list

This section provides an example of a situational problem along with possible tasks involved in its mathematical processing. The context can be used as a common thread throughout the learning situation. The learning activities are not spelled out; rather, the focus is on a relevant example of mathematical processing using the four phases in the problem-solving process: representation, planning, activation and reflection. Although not explicitly stated, the elements of the situational problem identified in the previous table, i.e. the broad area of learning, subject-specific competencies, family of learning situations, cross-curricular competencies and essential knowledge, can be discerned, and must form a coherent and meaningful whole.

Teachers may choose to use any of these elements as objects of learning. For instance, learning can focus on actions associated with the phases in the problem-solving process, actions related to the subject-specific or cross-curricular competencies, or actions related to the prescribed knowledge. Teachers can also use the example provided to construct other complex tasks or learning activities related to the mathematical knowledge adult learners must acquire.

Situational problem	Examples of possible tasks involved in the mathematical processing of a situational problem belonging to the <i>Processing data</i> family of learning situations
<p>As citizens, adult learners are called upon to exercise their right to vote on numerous occasions—in federal, provincial, municipal or other elections. From a list of candidates, they must choose the person they feel is the most suitable for the position in question.</p> <p>Before deciding who to vote for, adult learners must find out more about the various political platforms and check certain polls that track voting intentions. They realize that two polling firms have obtained different results regarding the candidate who is thought to be the likely winner.</p> <p>The method used by each polling firm must then be examined to explain the difference in the results.</p>	<p>Integrative process: <i>Comparing collections of data</i></p> <p>In carrying out the four phases in the problem-solving process, adult learners could:</p> <p>Representation</p> <ul style="list-style-type: none"> • Consult newspapers to find information that is produced by two different polling firms and that could be expressed using different registers of representation (data tables, graphs, etc.) <p>Planning</p> <ul style="list-style-type: none"> • List the steps to be carried out in order to properly compare these two polls <p>Activation</p> <ul style="list-style-type: none"> • Appropriately present the data provided by each of the firms (e.g. in the form of a table) in order to better compare them • Compare the statistical data provided, after using the same register of representation <p>Reflection</p> <ul style="list-style-type: none"> • Analyze the way in which the firms dealt with non-respondents • Analyze the way in which the firms presented their results to see if this promotes a particular point of view. Would another method of representing the data change the interpretation of the results?

END-OF-COURSE OUTCOMES

To solve situational problems in the family of learning situations *Processing data*, adult learners collect, compare and interpret data resulting from an experiment. To do this, they use the three subject-specific competencies, *Uses strategies to solve situational problems*, *Uses mathematical reasoning* and *Communicates by using mathematical language*.

To collect data pertaining to a one-variable distribution with a view to solving a situational problem, adult learners identify relevant information that can be presented verbally, graphically, or in a table of values or diagram. They work out their solution by following the main steps involved in statistical work, namely collecting and processing (interpreting and analyzing) data. They make conjectures and draw conclusions from their analysis of the results in order to make informed decisions. They decide whether a histogram or a box-and-whisker plot is the most appropriate register of representation for communicating the results of their analysis.

To compare collections of data, adult learners use tables, tree diagrams or geometric figures to conduct an effective comparative analysis. When data are graphed, the adults decode and interpret the elements of mathematical language and then use inductive or deductive reasoning to formulate the necessary propositions. They organize data from a sample in order to describe a population and make it easier to process the information. They check their solution by comparing different measures of central tendency and by validating the quartile measures using the corresponding graph.

Interpreting data resulting from a random experiment helps adult learners develop and use networks of mathematical cognitive resources which, in turn, help them derive through inductive reasoning properties and laws of probability using fractions and ratios. In solving problems, they use different strategies to represent the relationship between the results of the experiment and different concepts such as probable, certain or impossible events. They often proceed by analogy with games of chance, working with dice, cards or other objects to determine the constraints in a random experiment. Lastly, they check their solution by ensuring, for example, that the sum of the probabilities of an event and its complementary event is always equal to 1.

Throughout the problem-solving process, adult learners apply their mathematical knowledge (one-variable statistical distributions, theoretical and geometric probabilities). Their use of symbols, terms and notation related to this knowledge is accurate, and they always refer to different sources to validate the laws, theorems, corollaries or lemmas they deduce or induce so that they can improve their mathematical literacy. In addition, they do not hesitate to ask for help when they encounter difficulties.

EVALUATION CRITERIA FOR THE COMPETENCIES TARGETED BY THE COURSE***Uses strategies to solve situational problems***

- *Indication (oral or written) that the situational problem has been understood*
- *Application of strategies and appropriate mathematical knowledge*
- *Development of an appropriate solution**
- *Appropriate validation of the steps** in the solution*

* The solution includes a procedure, strategies and a final answer.

** The mathematical model, operations, properties or relations involved.

Uses mathematical reasoning

- *Formulation of a conjecture suited to the situation*
- *Correct use of appropriate mathematical concepts and processes*
- *Proper implementation of mathematical reasoning suited to the situation*
- *Proper organization of the steps in an appropriate procedure*
- *Correct justification of the steps in an appropriate procedure*

Communicates by using mathematical language

- *Correct interpretation of a mathematical message*
- *Production of a message in keeping with the terminology, notation and conventions of mathematics, and suited to the context*